Test report 2023-0314-EMC-TR-23-0226-V01

Designation:	CAP M2 17E/19/23/25T [AWS 1700] F-AC-F1
Manufacturer:	Commscope
Serial No(s):	FICMBA2338001
ID No.	7856326-1010 Rev: 00
FCC ID	XS5-CAPM217192325
Test Specification(s):	ANSI 63.26:2015 FCC Rules and Regulations as listed in 47 CFR, Part 20 and Part 27:2023-10-13
Test Plan:	"Infoblatt_für_CAP M2 17E_19_21_25T_ID7856326-1010 " from customer.

Date of issue:	2024-01-31		Signature:
Version:	01	Technical Reviewer:	Thomas Gerngroß Test Engineer Digitally signed by Thomas Gerngroß DN: cn=Thomas Gerngroß, o=Bureau Veritas CPS Germany GmbH, ou=ECL, email=thomas.gerngross@bureauveritas.com, c=DE Date: 2024.01.31 08:36:35 +01'00'
Date of receipt EUT:	2023-10-13		
Performance date:	2023-11-18 to 2023-12-13	Report Reviewer:	Thomas Hufnagel Test Engineer Digitally signed by Thomas Hufnagel Date: 2024.01.31 08:42:51 +01'00'

Bundesnetzagentur

BNetzA-CAB-19/21-20

ilac-MRA

DAkkS
Deutsche Akkreditierungsstelle
D-PL-12024-06-04

Client:	Commscope Andrew Wireless System GmbH Industriering 10 86675 Buchdorf Germany
Test laboratory:	Bureau Veritas Consumer Products Services Germany GmbH Thurn-und-Taxis-Straße 18 D-90411 Nürnberg Tel.: +49 40 74041 0
Test location:	Bureau Veritas Consumer Products Services Germany GmbH Thurn-und-Taxis-Straße 18 D-90411 Nürnberg

Laboratory accreditation no:	DAkkS D-PL-12024-06-04 BNETZA-CAB-19/21-20
FCC Designation Number:	DE0023
FCC Test Firm Registration:	366481

Versions management:

V 01.00	Initial release

Table of Contents

1 APPLIED STANDARDS AND TEST SUMMARY

1.1 CFR APPLIED STANDARDS

Type of Authorization
Certification for an Industrial Signal Booster.

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 and 20, 22 and 27. The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

Part 20, Commercial Mobiles Services

§ 20.21 Signal Boosters

Part 27; Miscellaneous Wireless Communications Services
Subpart C – Technical standards

§ 27.50 – Power and antenna height limits
§ 27.54 – Frequency stability
§ 27.53 – Emission limits

The tests were selected and performed with reference to:

- FCC Public Notice 935210 applying "Signal Boosters Basic Certification Requirements" 935210 D02, 2019-15-04.

- FCC Public Notice 935210 applying "Measurement guidance for industrial and non-consumer signal booster, repeater and amplifier devices"
- 935210 D05, 2019-04-03.

- FCC Public Notice 971168 applying "Measurement guidance for certification of licensed digital transmitters" 971168 D01, 2019-04-09.

- ANSI C63.26: 2015

Summary Test Results:

The EUT complies with all performed tests as listed in chapter 1.3 Measurement Summary/Signatures.

1.2 FCC REFERENCE TABLE

Measurement	FCC reference
Effective radiated power, mean output power and zone enhancer gain	§ 2.1046 § 27.50 KDB 935210 D05 v01r04: 3.5
Peak to Average Ratio	§ 27.50
Occupied bandwidth Input-versus-output spectrum	§ 2.1049 KDB 935210 D05 v01r04: 3.4
Conducted spurious Emission at Antenna Terminal	§ 2.1051 § 27.53 KDB 935210 D05 v01r04: 3.6
Out-of-band emissions limits	§ 2.1051 § 27.53 KDB 935210 D05 v01r04: 3.6
Frequency stability	§ 2.1055 § 27.54
Field strength of spurious radiation	§ 2.1053 § 27.53
Out-of-band rejection	KDB 935210 D05 v01r04: 3.3
All measurements	ANSI 63.26

1.3 MEASUREMENT SUMMARY/SIGNATURES

47 CFR CHAPTER I FCC PART 27 Subpart C [Base Stations/Repeater] **§ 2.1046, § 27.50**

Effective Radiated Power, mean output power and zone enhancer gain
The measurement was performed according to ANSI C63.26, KDB 935210 D05 v01r04: 3.5 — **Final Result**

OP-Mode

Frequency Band, Direction, Input Power, Signal Type	
AWS 1700, RF downlink, 0.3 dB < AGC, Wideband	Passed
AWS 1700, RF downlink, 3 dB > AGC, Wideband	Passed
AWS 1700, RF downlink, 0.3 dB < AGC, Narrowband	Passed
AWS 1700, RF downlink, 3 dB > AGC, Narrowband	Passed
AWS 1700, RF downlink, 0.3 dB < AGC, Wideband 5G	Passed
AWS 1700, RF downlink, 3 dB > AGC, Wideband 5G	Passed

47 CFR CHAPTER I FCC PART 27 Subpart C [Base Stations/Repeater] **§ 27.50**

Peak to Average Ratio
The measurement was performed according to ANSI C63.26 — **Final Result**

AWS 1700, RF downlink, 0.3 dB < AGC, Wideband	Passed
AWS 1700, RF downlink, 3 dB > AGC, Wideband	Passed
AWS 1700, RF downlink, 0.3 dB < AGC, Narrowband	Passed
AWS 1700, RF downlink, 3 dB > AGC, Narrowband	Passed
AWS 1700, RF downlink, 0.3 dB < AGC, Wideband 5G	Passed
AWS 1700, RF downlink, 3 dB > AGC, Wideband 5G	Passed

47 CFR CHAPTER I FCC PART 27 Subpart C [Base Stations/Repeater] **§ 2.1049**

Occupied Bandwidth/Input-versus-output Spectrum
The measurement was performed according to ANSI C63.26, KDB 935210 D05 v01r04: 3.4 — **Final Result**

OP-Mode

Frequency Band, Direction, Input Power, Signal Type	
AWS 1700, RF downlink, 0.3 dB < AGC, Wideband	Passed
AWS 1700, RF downlink, 3 dB > AGC, Wideband	Passed
AWS 1700, RF downlink, 0.3 dB < AGC, Narrowband	Passed
AWS 1700, RF downlink, 3 dB > AGC, Narrowband	Passed
AWS 1700, RF downlink, 0.3 dB < AGC, Wideband 5G	Passed
AWS 1700, RF downlink, 3 dB > AGC, Wideband 5G	Passed

47 CFR CHAPTER I FCC PART 27 Subpart C [Base Stations/Repeater] **§ 2.1051, § 27.53**

Conducted spurious emissions at antenna terminals
The measurement was performed according to ANSI C63.26 **Final Result**

OP-Mode

Frequency Band, Direction, Input Power, Signal Type	
AWS 1700, low, RF downlink, Wideband	
AWS 1700, mid, RF downlink, Wideband	Passed
AWS 1700, high, RF downlink, Wideband	Passed
AWS 1700low, RF downlink, Narrowband	Passed
AWS 1700, mid, RF downlink, Narrowband	Passed
AWS 1700, high, RF downlink, Narrowband	Passed
AWS 1700, low, RF downlink, Wideband 5G	Passed
AWS 1700, mid, RF downlink, Wideband 5G	Passed
AWS 1700, high, RF downlink, Wideband 5G	Passed

47 CFR CHAPTER I FCC PART 27 Subpart C [Base Stations/Repeater] **§2.1051, § 27.53**

Out-of-band emission limits

The measurement was performed according to ANSI C63.26, KDB 935210 D05 v01r04: 3.6

OP-Mode

Band Edge, Frequency Band, Number of signals, Direction, Input Power, Signal Type

Upper, Band 66 AWS 1700, 1, RF downlink, 0.3 dB < AGC, Wideband	Passed
Upper, Band 66 AWS 1700, 1, RF downlink, 3 dB > AGC, Wideband	Passed
Upper, Band 66 AWS 1700, 1, RF downlink, 0.3 dB < AGC, Wideband 5G	Passed
Upper, Band 66 AWS 1700, 1, RF downlink, 3 dB > AGC, Wideband 5G	Passed
Upper, Band 66 AWS 1700, 1, RF downlink, 0.3 dB < AGC, Narrowband	Passed
Upper, Band 66 AWS 1700, 1, RF downlink, 3 dB > AGC, Narrowband	Passed
Lower, Band 66 AWS 1700, 1, RF downlink, 0.3 dB < AGC, Wideband	Passed
Lower, Band 66 AWS 1700, 1, RF downlink, 3 dB > AGC, Wideband	Passed
Lower, Band 66 AWS 1700, 1, RF downlink, 0.3 dB < AGC, Wideband 5G	Passed
Lower, Band 66 AWS 1700, 1, RF downlink, 3 dB > AGC, Wideband 5G	Passed
Lower, Band 66 AWS 1700, 1, RF downlink, 0.3 dB < AGC, Narrowband	Passed
Lower, Band 66 AWS 1700, 1, RF downlink, 3 dB > AGC, Narrowband	Passed
Upper, Band 66 AWS 1700, 2, RF downlink, 0.3 dB < AGC, Wideband	Passed
Upper, Band 66 AWS 1700, 2, RF downlink, 3 dB > AGC, Wideband	Passed
Upper, Band 66 AWS 1700, 2, RF downlink, 0.3 dB < AGC, Narrowband	Passed
Upper, Band 66 AWS 1700, 2, RF downlink, 3 dB > AGC, Narrowband	Passed
Lower, Band 66 AWS 1700, 2, RF downlink, 0.3 dB < AGC, Wideband	Passed
Lower, Band 66 AWS 1700, 2, RF downlink, 3 dB > AGC, Wideband	Passed
Lower, Band 66 AWS 1700, 2, RF downlink, 0.3 dB < AGC, Narrowband	Passed
Lower, Band 66 AWS 1700, 2, RF downlink, 3 dB > AGC, Narrowband	Passed

47 CFR CHAPTER I FCC PART 27 Subpart C [Base Stations/Repeater] **KDB 935210 D05 v01r04: 3.3**

Out-of-band rejection
The measurement was performed according to ANSI C63.26; KDB 935210 D05 v01r04: 3.3 **Final Result**

OP-Mode **Setup**
Frequency Band, Direction
Band 66 AWS 1700, RF downlink Passed

47 CFR CHAPTER I FCC PART 27 Subpart C [Base Stations/Repeater] **§2.1055, §27.54**

Frequency stability

Final Result

OP-Mode Not applicable
Not applicable

47 CFR CHAPTER I FCC PART 27 Subpart C [Base Stations/Repeater] **§ 2.1053, § 27.53**

Field strength of spurious radiation
The measurement was performed according to ANSI C63.26 **Final Result**

OP-Mode, one antenne in use
Frequency Band, Test Frequency, Direction
AWS 1700, RF downlink Passed

OP-Mode, MIMO
Frequency Band, Test Frequency, Direction
AWS 1700, RF downlink Passed

The test case frequency stability was not performed, since the EUT is not equipped with signal processing capabilities.

Report version control			
Version	**Release date**	**Change Description**	**Version validity**
Initial	2024-01-31	--	Valid

2 ADMINISTRATIVE DATA

2.1 TESTING LABORATORY

Bureau Veritas Consumer Products Services
Germany GmbH
Thurn-und-Taxis-Straße 18
D-90411 Nürnberg
Tel.: +49 40 74041 0
Fax: +49 40 74041-2755

2.2 APPLICANT DATA

Company Name:	Commscope Andrew Wireless Systems GmbH
Address:	Industriering 10 86675 Buchdorf Germany
Contact Person:	Mr. Jiri Cecka

2.3 MANUFACTURER DATA

Company Name:	Please see applicant data.
Address:	Please see applicant data.

3 TEST OBJECT DATA

3.1 GENERAL EUT DESCRIPTION

Kind of Device product description	Cellular Repeater
Product name	Cellular Repeater
Type	CAP M2 17E/19/23/25T F-AC-F1
Declared EUT data by the supplier	
General Product Description	The EUT is an industrial signal booster supporting the following: Band 66 (AWS-1700): 2110 – 2180 MHz A RF operation is only supported for the downlink.
Booster Type	Industrial Signal Booster
Voltage Type	AC
Voltage Level	100 to 240 V
Maximum Output Donor Port [Uplink]	-
Nominal Output Server Port [Downlink]	33 dBm
Nominal Gain [Uplink]	-
Nominal Gain [Downlink]	38 dB

The main components of the EUT are listed and described in chapter 3.2 EUT Main components.

3.2 EUT MAIN COMPONENTS

Sample Parameter	Value
Serial Number	FICMBA2338001
HW Version	7856326-1010 Rev: 00
SW Version	V5.0.0.196
Comment	-----

NOTE: The short description is used to simplify the identification of the EUT in this test report.

3.3 ANCILLARY EQUIPMENT

For the purposes of this test report, ancillary equipment is defined as equipment which is used in conjunction with the EUT to provide operational and control features to the EUT. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Ancillary Equipment can influence the test results.

Device	Details (Manufacturer, Type Model, OUT Code)	Description
-	-	-

3.4 AUXILIARY EQUIPMENT

For the purposes of this test report, auxiliary equipment is defined as equipment which is used temporarily to enable operational and control features especially used for the tests of the EUT which is not used during normal operation or equipment that is used during the tests in combination with the EUT but is not subject of this test report. It is necessary to configure the system in a typical fashion, as a customer would normally use it.
But nevertheless Auxiliary Equipment can influence the test results.

Device	**Details (Manufacturer, Type, S/N)**	**Description**
AUX1	Commscope, ION-E PSU Shelf AC, DC18596	Power supply rack
	GE Power Electronisc Inc., CAR1212FPBC-Z, DC17936	Power plug-in module
AUX2	Commscope, ION-E WCS-2, SZAEAJ1819A0005	Module rack
	Commscope, ION-E OPT, SZBEAD2012A0115	Optical plug-in module
	Commscope, RFD HB, SZBEAQ2140A0006	RF card plug-in module
	Commscope, RFD HB, SZBEAG2210A0008	RF card plug-in module
	Commscope, ION-E RFD, SZBEAG1825A0018	RF card plug-in module
	Commscope, ION-E RFD, SZBEAP2103A0457	RF card plug-in module

3.5 EUT SETUPS

This chapter describes the combination of EUTs and equipment used for testing. The rationale for selecting the EUTs, ancillary and auxiliary equipment and interconnecting cables, is to test a representative configuration meeting the requirements of the referenced standards.

Setup	Combination of EUTs	Description and Rationale
	,	Setup for all tests

3.6 OPERATING MODES

This chapter describes the operating modes of the EUT used for testing.

3.6.1 TEST CHANNELS

Band	Direction	Lower Frequency Band Edge [MHz]	Upper Frequency Band Edge [MHz]	Center Frequency [MHz]	Port
66, AWS 1700	Downlink	2110.00	2180	2145.00	Donor

3.6.2 DEFINITION OF USED FREQUENCY BANDS

Narrowband: representation by a GSM signal
Wideband : representation by an AWGN signal with 4.1 MHz
Wideband 5G: representation by an AWGN signal with 43.6 MHz

3.6.3 AUTOMATIC GAIN CONTROL LEVEL

AGC Levels							
Band	**Direction**	**Signal Type**	**AGC Start Pin [dBm]**	**AGC Start Pin -0.3 dB [dBm]**	**AGC Start Pin +3 dB [dBm]**	**Frequency [MHz]**	**Frequency**
66	Downlink	Narrowband	-3.7	-4.0	-0.7	2146.0	Mid
66	Downlink	Wideband	-3.5	-3.8	-0.5	2145.0	
66	Downlink	Wideband 5G	-3.5	-3.8	-0.5	2145.0	
66	Downlink	Narrowband	-3.6	-3.9	-0.6	2110.2	Low
66	Downlink	Wideband	-3.4	-3.7	-0.4	2112.5	
66	Downlink	Wideband 5G	-4.3	-4.0	-1.0	2132.5	
66	Downlink	Narrowband	-7.6	-7.9	-4.6	2179.8	High
66	Downlink	Wideband	-3.4	-3.1	0.2	2177.5	
66	Downlink	Wideband 5G	-3.7	-3.4	-0.4	2157.5	
66	Downlink	Narrowband	-4.5	-4.8	-1.6	2136.2	Max.Power
66	Downlink	Wideband	-4.3	-4.6	-1.2	2136.2	
66	Downlink	Wideband 5G	-3.5	-3.8	-05	2145.0	

Remark:

If the measured frequency f_0 for the max power has a too low distance to the band edges, because in the tests modulated signals must be used: The next possible frequency to the according band edge is used.
For example for minimum distances to the band edges:

GSM signal (narrowband): 0.2 MHz
AWGN signal (wideband): 2.5 MHz
AWGN signal (wideband 5G): Here only measurements at the mid frequency are possible, because the signal band has the same bandwidth as the used channel.

3.6.4 REMARKS TO THE MEASUREMENTS

Cause of an inappropriate control mode in the transmission of the narrowband signal (GSM signal) at f_{mid}, f_{mid} is increased by 1 MHz, Hereby the abbreviations are:

f_{mid} for wideband signals (AWGN signals)
f_{mid+1} for narrowband signals (GSM signals)

In the real use of the repeater narrowband signals aren't used.

3.7 PRODUCT LABELLING

3.7.1 FCC ID LABEL

Please refer to the documentation of the applicant.

3.7.2 LOCATION OF THE LABEL ON THE EUT

Please refer to the documentation of the applicant.

4 TEST RESULTS

4.1 EFFECTIVE RADIATED POWER, MEAN OUTPUT POWER AND ZONE ENHANCER GAIN

Standard FCC Part 27, §27.50

The test was performed according to:
ANSI C63.26, KDB 935210 D05 v01r04: 3.5

Test date: 2023-11-19 to 2023-11-20

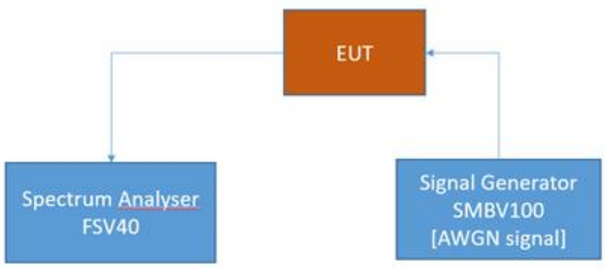
Environmental conditions: 23 °C ± 5 K; 40 % r. F. ± 20 % r. F.

Test engineer: Thomas Hufnagel

4.1.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the signal booster power and gain limits and requirements for industrial signal boosters.

The EUT was connected to the test setup according to the following diagram:



FCC Part 22/24/27/90 Industrial signal booster – Test Setup; RF Output Power / Gain

The attenuation of the measuring and stimulus path are known for each measured frequency and are considered.

The Spectrum Analyzer settings can be directly found in the measurement diagrams.

4.1.2 TEST REQUIREMENTS/LIMITS: ABSTRACTS FROM STANDARDS

Part 27; Miscellaneous Wireless Communication Services

Subpart C – Technical standards

§ 27.50

Abstract § 27.50 from FCC:

(d) The following power and antenna height requirements apply to stations transmitting in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz and 2180-2200 MHz bands:

(1) The power of each fixed or base station transmitting in the 1995-2000 MHz, 2110-2155 MHz, 2155-2180 MHz or 2180-2200 MHz band and located in any county with population density of 100 or fewer persons per square mile, based upon the most recently available population statistics from the Bureau of the Census, is limited to:

(i) An equivalent isotropically radiated power (EIRP) of 3280 watts when transmitting with an emission bandwidth of 1 MHz or less;

(ii) An EIRP of 3280 watts/MHz when transmitting with an emission bandwidth greater than 1 MHz.

(2) The power of each fixed or base station transmitting in the 1995-2000 MHz, the 2110-2155 MHz 2155-2180 MHz band, or 2180-2200 MHz band and situated in any geographic location other than that described in paragraph (d)(1) of this section is limited to:

(i) An equivalent isotropically radiated power (EIRP) of 1640 watts when transmitting with an emission bandwidth of 1 MHz or less;

(ii) An EIRP of 1640 watts/MHz when transmitting with an emission bandwidth greater than 1 MHz.

4.1.3 TEST PROTOCOL

Band 66 AWS 1700, downlink,							
Signal Type	**Input Power**	**Frequency [MHz]**	**Input Power [dBm]**	**Maximum Average Output Power [dBm]**	**Limit Average Output Power [dBm]**	**Margin to Limit [dB]**	**Gain [dB]**
Wideband	0.3 dB < AGC	2136.2	-4.6	33.1	62.1	29.0	37.7
Wideband	3 dB > AGC	2136.2	-1.2	33.1	62.1	29.0	34.3
Narrowband	0.3 dB < AGC	2136.2	-4.8	32.9	62.1	29.2	37.7
Narrowband	3 dB > AGC	2136.2	-1.6	33.1	62.1	29.0	34.7
Wideband 5G	0.3 dB < AGC	2145.0	-3.8	33.2	62.1	28.9	37.0
Wideband 5G	3 dB > AGC	2145.0	-0.5	33.2	62.1	28.9	33.8

Remark: Please see next sub-clause for the measurement plot.

Maximum output power at the worst case consideration

The highest power level in the tables above is
$p_{highest}$ = 33.2 dBm at the channel which has the most output power of all channels.

Hereby at an antenna gain of G_{dB} = 15 dBi the highest effecitve radiated output power EIRP $p_{EIRP\ 1CH}$ of one channel is:

$p_{EIRP\ 1CH} = p_{highest} + G_{dB}$

This results in:

$p_{EIRP\ 1CH}$ = 33.2 dBm + 15 dB = 48.2 dBm

The eqivalent power P is according the given formula:

$p_{EIRP\ 1CH}$ =

$$P\ EIRP\ 1CH\ [W] = 10\text{EXP}(p\ EIRP\ 1CH\ [dBm]\ /\ 10) * 0.001\ [W]$$

This results in:

$$P\ EIRP\ 1CH\ [W] = 10\text{EXP}(48.2\ [dBm]\ /\ 10) * 0.001\ [W] = 66.1\ \text{W}$$

Supposed all four antenna ports are working together in MIMO operation the worst case of the highest output power $p_{EIRP\ 2CH}$ is:

$p_{EIRP\ 2CH} = 2 * p_{EIRP\ 1CH}$

This results in:

$p_{EIRP\ 4CH}$ = 2 * 66.1 W =132.2 W

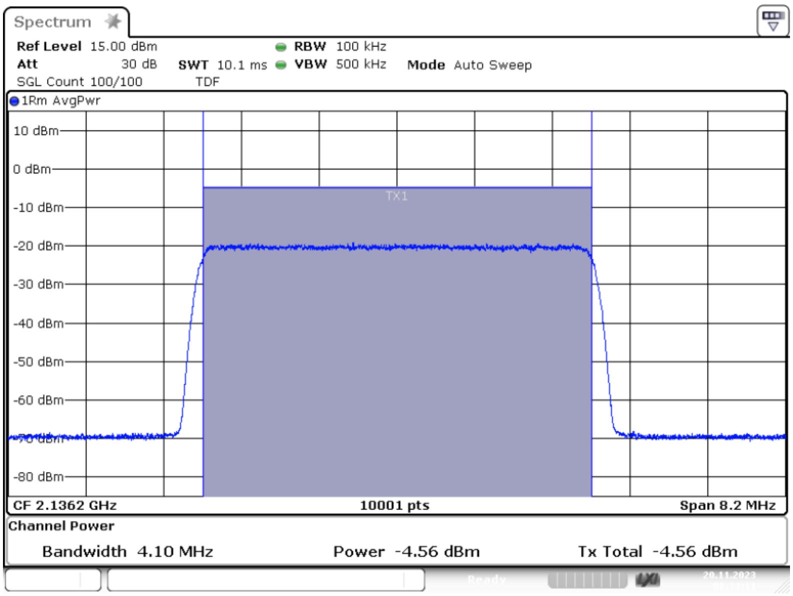
Final result of this consideration:

$p_{EIRP\ 4CH}$ = 132.2 W <1640 W, hereby 1640 W is the highest allowed limit in this band.

The DUT doesn’t exceed the limit.

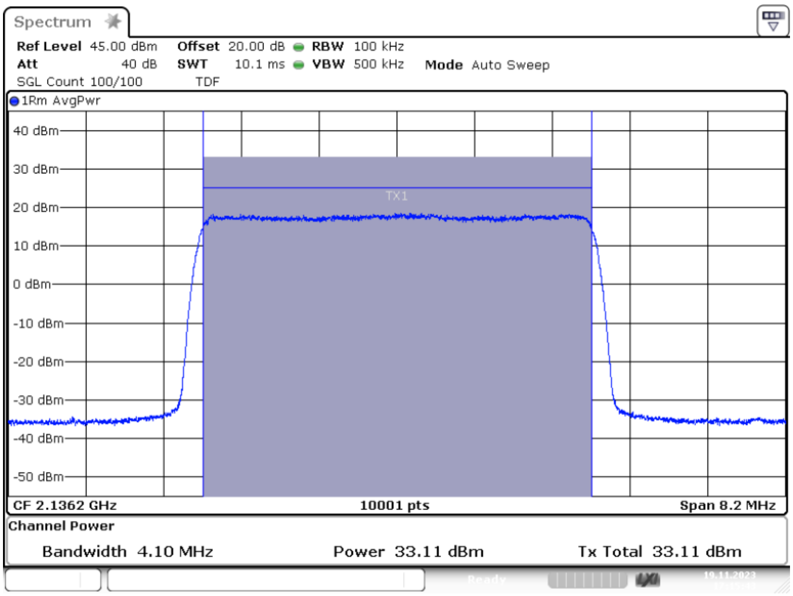
4.1.4 MEASUREMENT PLOT

Band: .AWS 1700; ANT 1; Frequency: 2.1362 GHz; Band Edge: f0; Mod: AWGN; Input Power 0.3 dB < AGC



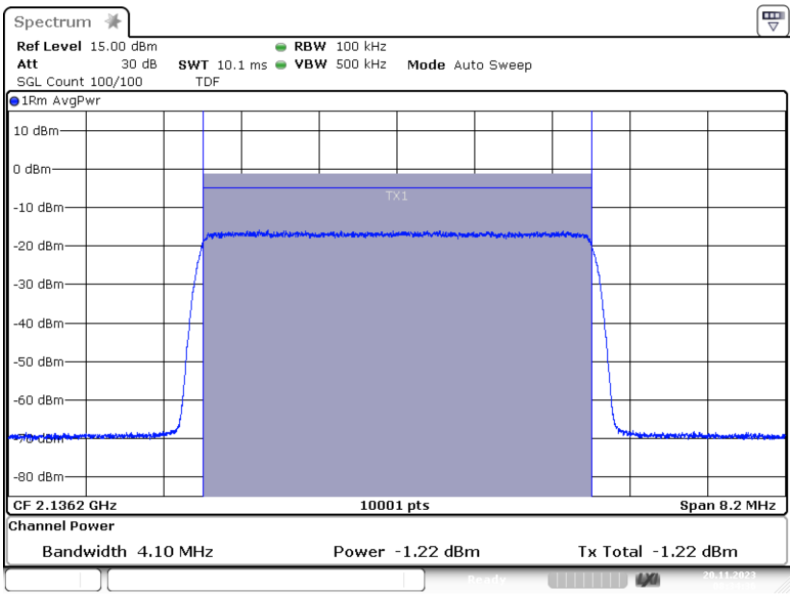
3.5.3 Power AWGN In-0.3 2.13620G

Band: .AWS 1700; ANT 1; Frequency: 2.1362 GHz; Band Edge: f0; Mod: AWGN; Output Power 0.3 dB < AGC



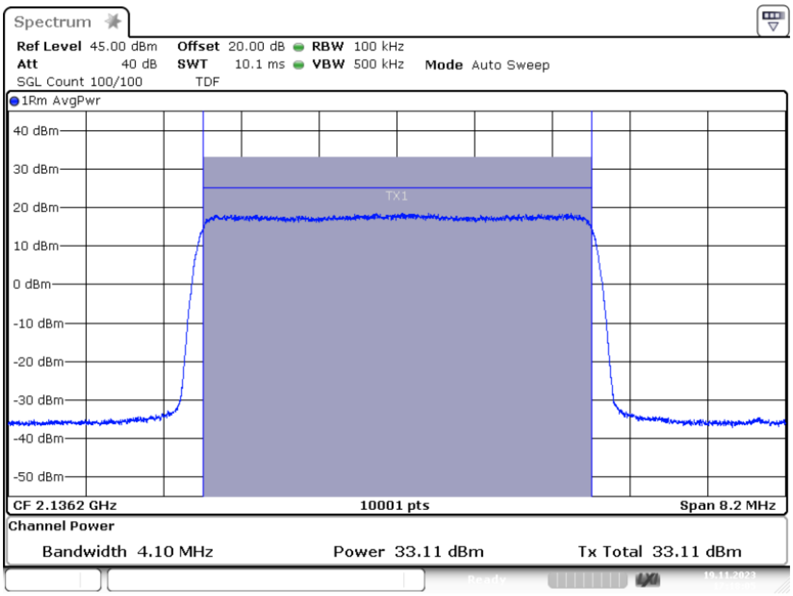
3.5.3 Power AWGN Out -0.3 2.13620G

Band: .AWS 1700; ANT 1; Frequency: 2.1362 GHz; Band Edge: f0; Mod: AWGN; Input Power 3 dB > AGC



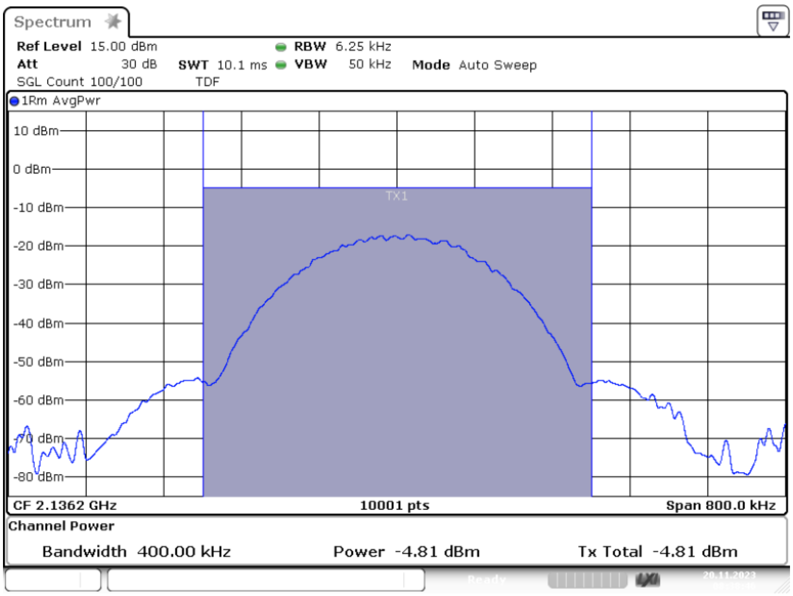
3.5.3 Power AWGN In+3 2.13620G

Band: .AWS 1700; ANT 1; Frequency: 2.1362 GHz; Band Edge: f0; Mod: AWGN; Output Power 3 dB > AGC



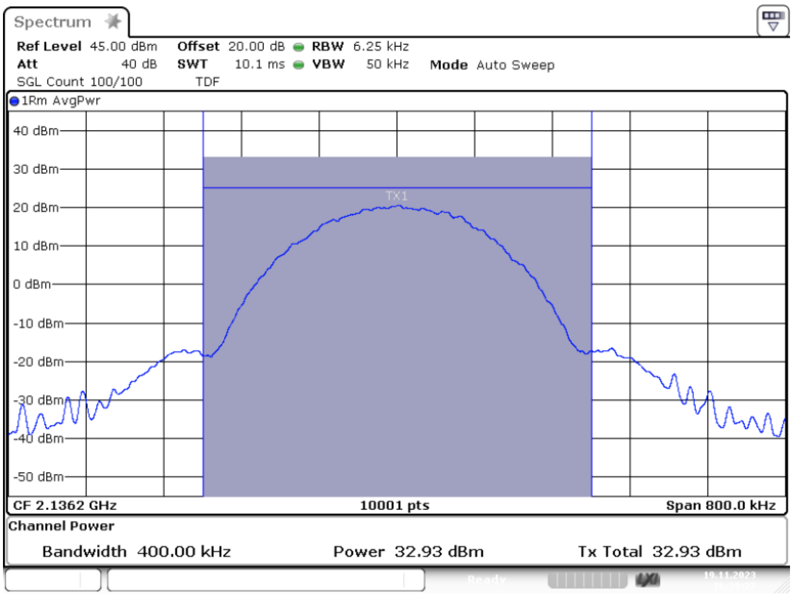
3.5.3 Power AWGN Out +3 2.13620G

Band: .AWS 1700; ANT 1; Frequency: 2.1362 GHz; Band Edge: f0; Mod: GSM; Input Power 0.3 dB < AGC



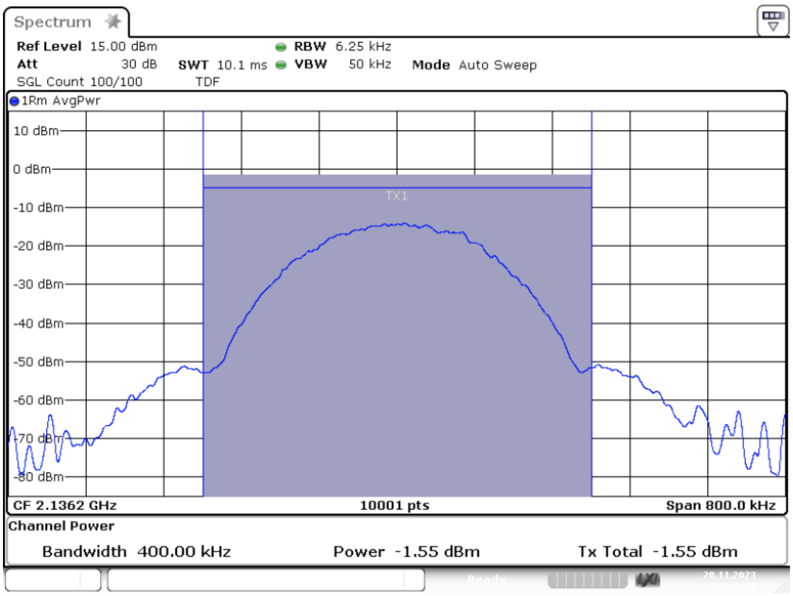
3.5.3 Power GSM In-0.3 2.136200

Band: .AWS 1700; ANT 1; Frequency: 2.1362 GHz; Band Edge: f0; Mod: GSM; Output Power 0.3 dB < AGC



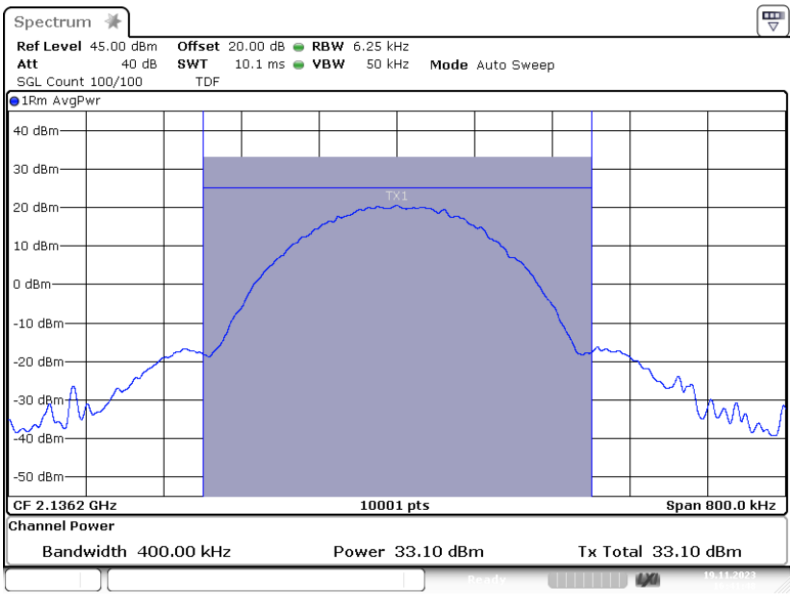
3.5.3 Power GSM Out -0.3 2.136200

Band: .AWS 1700; ANT 1; Frequency: 2.1362 GHz; Band Edge: f0; Mod: GSM; Input Power 3 dB > AGC



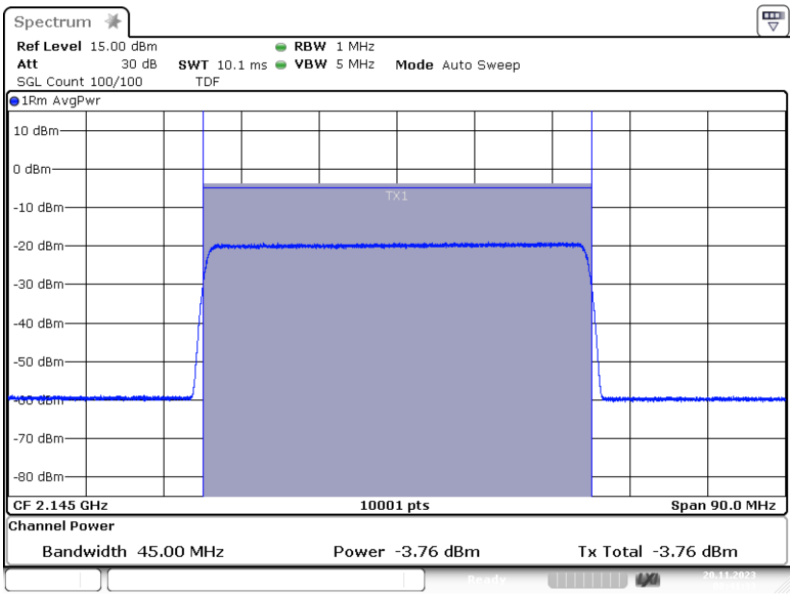
3.5.3 Power GSM In+3 2.13620G

Band: .AWS 1700; ANT 1; Frequency: 2.1362 GHz; Band Edge: f0; Mod: GSM; Output Power 3 dB > AGC



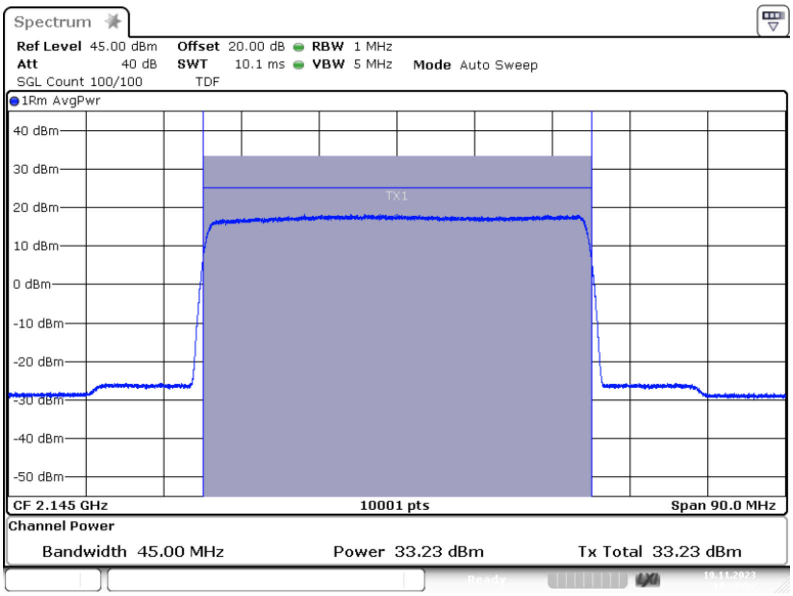
3.5.3 Power GSM Out +3 2.13620G

Band: .AWS 1700; ANT 1; Frequency: 2.1450 GHz; Band Edge: mid; Mod: AWGN 45M; Input Power 0.3 dB < AGC



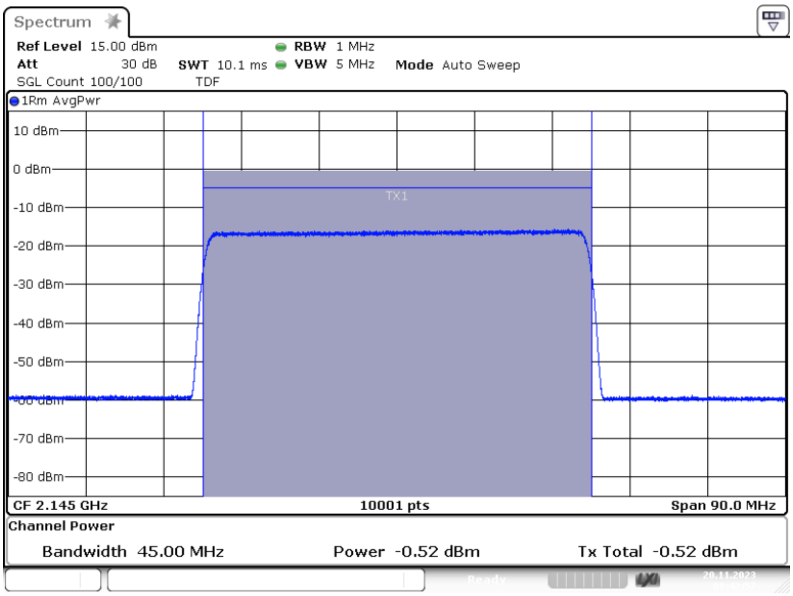
3.5.3 Power AWGN 45M In-0.3 2.14500G

Band: .AWS 1700; ANT 1; Frequency: 2.1450 GHz; Band Edge: mid; Mod: AWGN 45M; Output Power 0.3 dB < AGC



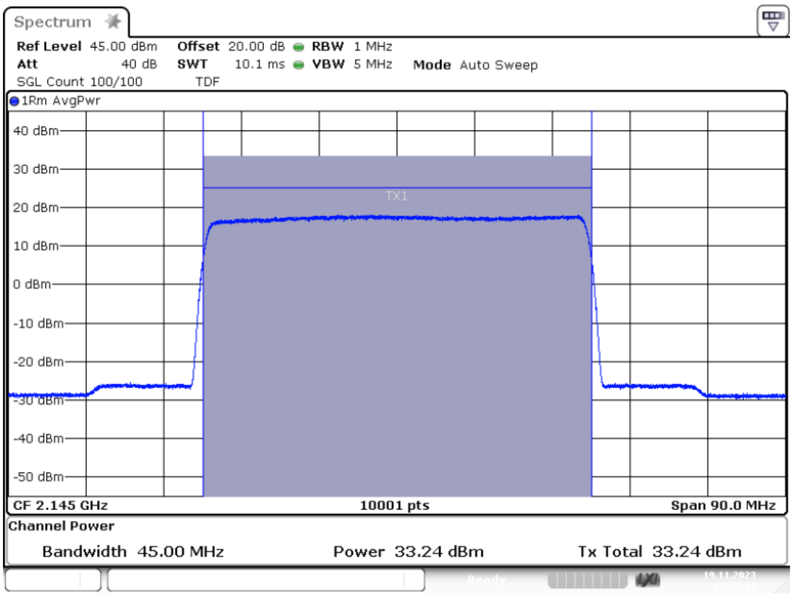
3.5.3 Power AWGN 45M Out -0.3 2.14500G

Band: .AWS 1700; ANT 1; Frequency: 2.1450 GHz; Band Edge: mid; Mod: AWGN 45M; Input Power 3 dB > AGC



3.5.3 Power AWGN 45M In+3 2.14500G

Band: .AWS 1700; ANT 1; Frequency: 2.1450 GHz; Band Edge: mid; Mod: AWGN 45M; Output Power 3 dB > AGC



3.5.3 Power AWGN 45M Out +3 2.14500G

4.1.5 TEST EQUIPMENT USED

- Conducted

4.2 PEAK TO AVERAGE RATIO

Standard FCC PART 27, § 27.50

The test was performed according to:
ANSI C63.26

Test date: 2023-11-19 to 2023-11-20

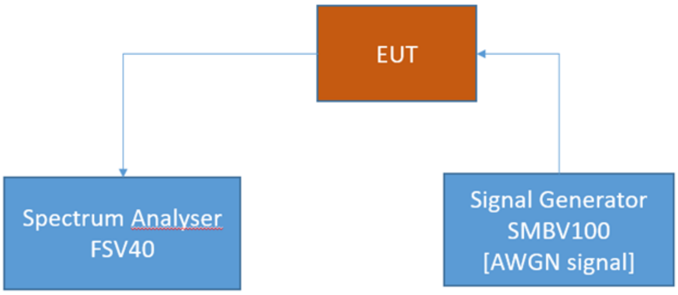
Environmental conditions: 23 °C ± 5 K; 40 % r. F. ± 20 % r. F.

Test engineer: Thomas Hufnagel

4.2.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the signal booster power and gain limits and requirements for industrial signal booster.

The EUT was connected to the test setup according to the following diagram:



FCC Part 22/24/27/90 Industrial signal booster – Test Setup; RF Output Power / Gain

The attenuation of the measuring and stimulus path are known for each measured frequency and are considered.

The Spectrum Analyzer settings can be directly found in the measurement diagrams.

4.2.2 TEST REQUIREMENTS/LIMITS

Subpart C – Technical standards

§ 27.50

Abstract § 27.50 from FCC:

(d) The following power and antenna height requirements apply to stations transmitting in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz and 2180-2200 MHz bands:

(5) Equipment employed must be authorized in accordance with the provisions of §24.51. Power measurements for transmissions by stations authorized under this section may be made either in accordance with a Commission-approved average power technique or in compliance with paragraph (d)(6) of this section. In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB.

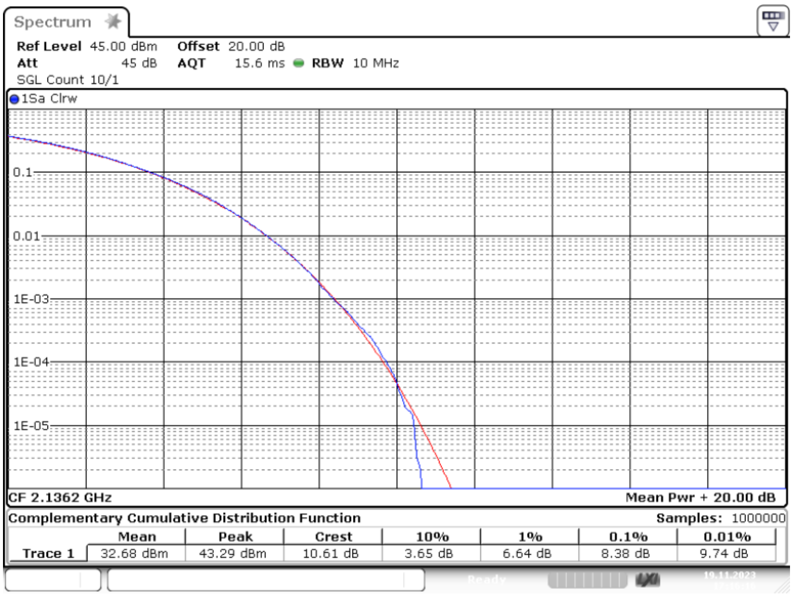
4.2.3 TEST PROTOCOL

Band 66 AWS 1700, downlink						
Signal Type	**Input Power**	**Frequency [MHz]**	**Input Power [dBm]**	**PAPR [dB]**	**Limit PAPR [dB]**	**Margin to Fictive Limit [dB]**
Wideband	0.3 dB < AGC	2136.2	-4.6	8.4	13.0	4.6
Wideband	3 dB > AGC	2136.2	-1.2	8.4	13.0	4.7
Narrowband	0.3 dB < AGC	2136.2	-4.8	0.2	13.0	12.8
Narrowband	3 dB > AGC	2136.2	-1.6	0.2	13.0	12.8
Wideband 5G	0.3 dB < AGC	2145.0	-3.8	8.4	13.0	4.6
Wideband 5G	3 dB > AGC	2145.0	-0.5	8.5	13.0	4.5

Remark: Please see next sub-clause for the measurement plot.

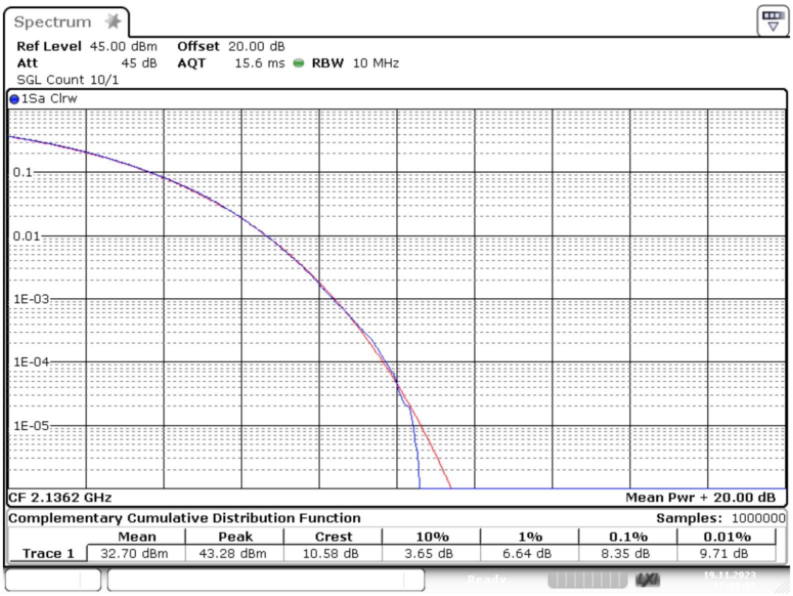
4.2.4 MEASUREMENT PLOT (SHOWING VALUE)

Band: .AWS 1700; ANT 1; Frequency: 2.1362 GHz; Band Edge: f0; Mod: AWGN; PAPR 0.3 dB < AGC



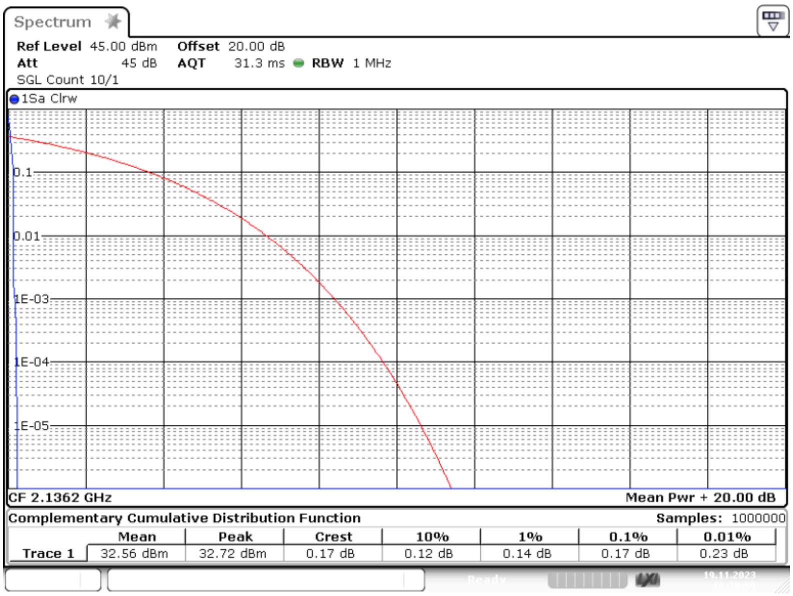
4.0 PAPR AWGN Out -0.3 2.136G

Band: .AWS 1700; ANT 1; Frequency: 2.1362 GHz; Band Edge: f0; Mod: AWGN; PAPR 3 dB > AGC



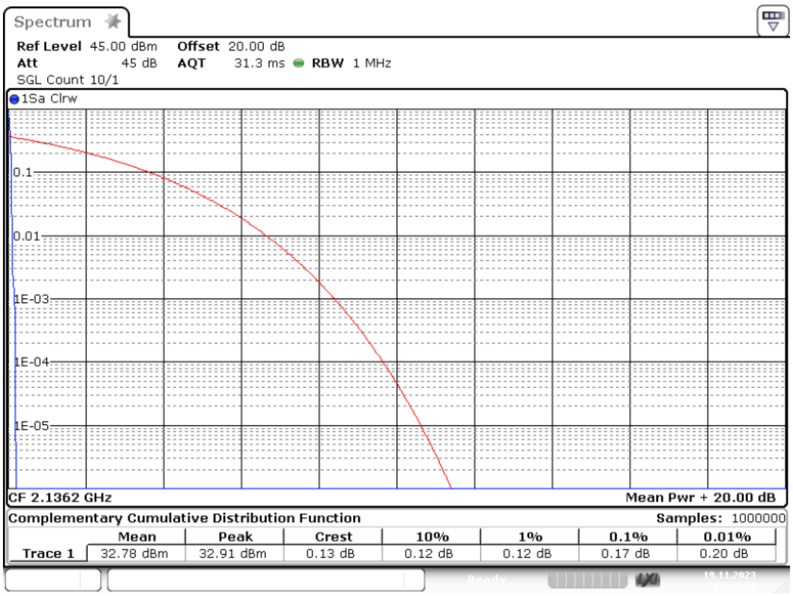
4.0 PAPR AWGN Out +3 2.136G

Band: .AWS 1700; ANT 1; Frequency: 2.1362 GHz; Band Edge: f0; Mod: GSM; PAPR 0.3 dB < AGC



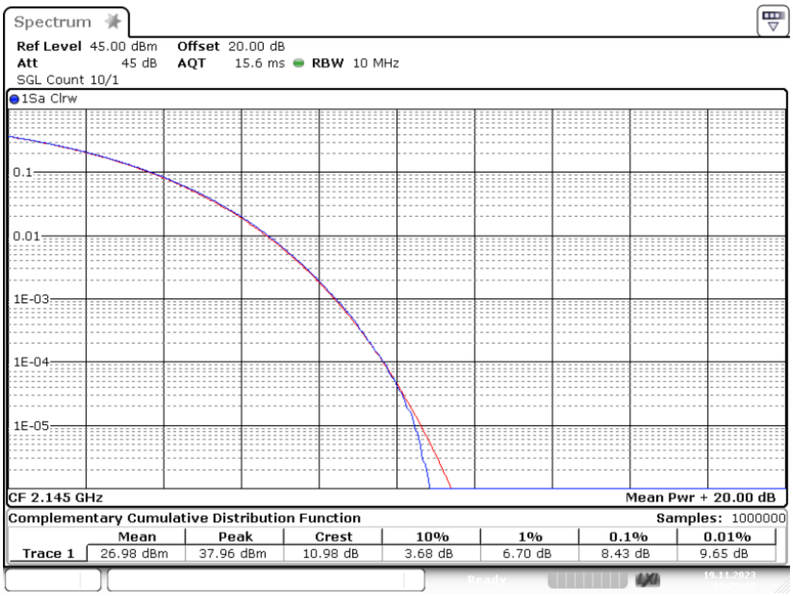
4.0 PAPR GSM Out -0.3 2.136G

Band: .AWS 1700; ANT 1; Frequency: 2.1362 GHz; Band Edge: f0; Mod: GSM; PAPR 3 dB > AGC



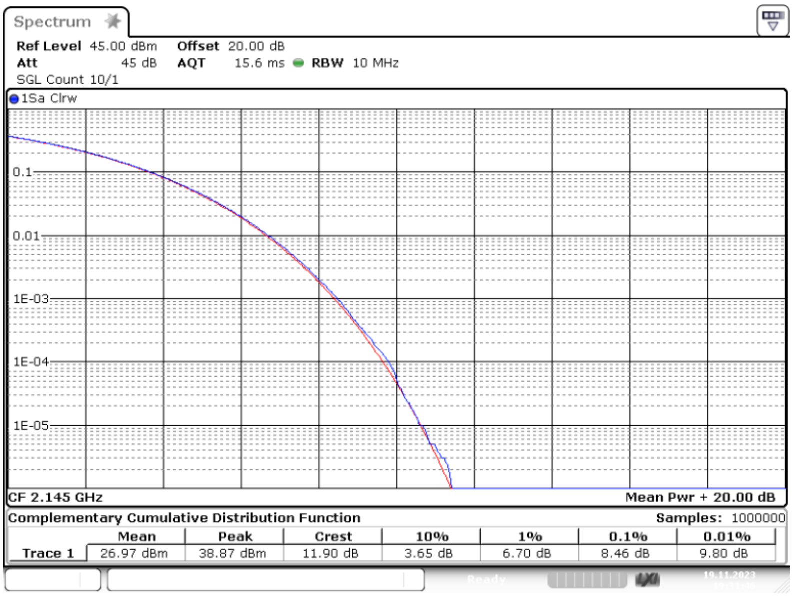
4.0 PAPR GSM Out +3 2.136G

Band: .AWS 1700; ANT 1; Frequency: 2.1450 GHz; Band Edge: mid; Mod: AWGN 45M; PAPR 0.3 dB < AGC



4.0 PAPR AWGN 45M Out -0.3 2.145G

Band: .AWS 1700; ANT 1; Frequency: 2.1450 GHz; Band Edge: mid; Mod: AWGN 45M; PAPR 3 dB > AGC



4.0 PAPR AWGN 45M Out +3 2.145G

4.2.5 TEST EQUIPMENT USED

- Conducted

4.3 OCCUPIED BANDWIDTH/INPUT-VERSUS-OUTPUT SPECTRUM

Standard FCC Part 2.1049; Occupied Bandwidth

The test was performed according to:
ANSI C63.26, KDB 935210 D05 v01r04: 3.4

Test date: 2023-11-19 to 2023-11-20

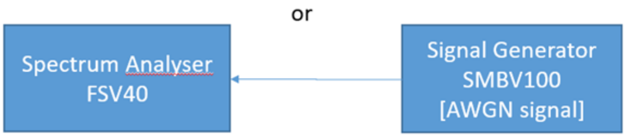
Environmental conditions: 23 °C ± 5 K; 40 % r. F. ± 20 % r. F.

Test engineer: Thomas Hufnagel

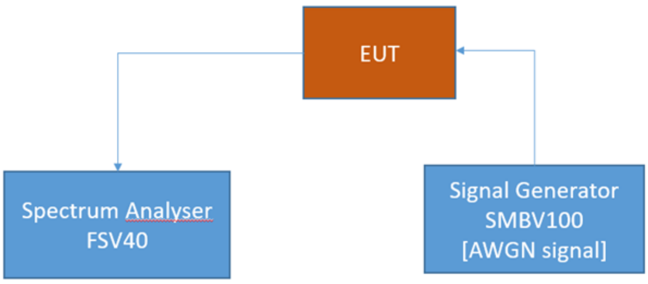
4.3.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the applicable conducted spurious emission limits.

The EUT was connected to the test setups according to the following diagram:



FCC Part 22/24/27/90; Industrial Signal Booster
Test Setup step 1: Measuring characteristics of test signals



FCC Part 22/24/27/90; Industrial Signal Booster
Test Setup step 2; Occupied Bandwidth/Input-versus-output spectrum

The attenuation of the measuring and stimulus path are known for each measured frequency and are considered.

The Spectrum Analyzer settings can be directly found in the measurement diagrams.

4.3.2 TEST REQUIREMENTS/LIMITS

Abstract § 2.1049 from FCC:

FCC Part 2.1049; Occupied Bandwidth:

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.3 percent of the total mean power radiated by a given emission shall be measured under the following conditions as applicable:

(h) Transmitters employing digital modulation techniques—when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment will be operated. The signal shall be applied through any filter networks, pseudo-random generators or other devices required in normal service. Additionally, the occupied bandwidth shall be shown for operation with any devices used for modifying the spectrum when such devices are optional at the discretion of the user.

(i) Transmitters designed for other types of modulation—when modulated by an appropriate signal of sufficient amplitude to be representative of the type of service in which used. A description of the input signal should be supplied.

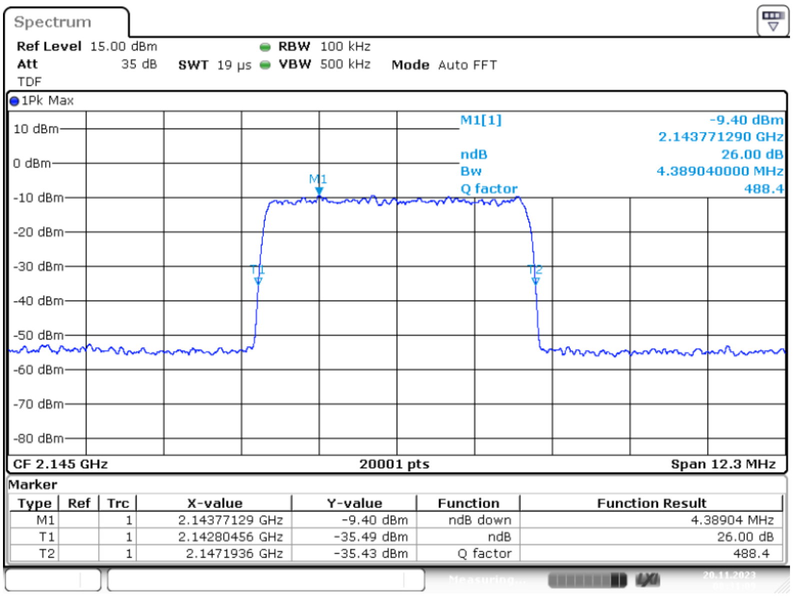
4.3.3 TEST PROTOCOL

Band 66 AWS 1700, downlink							
Signal Type	**Input Power**	**Signal Frequency [MHz]**	**Occupied Bandwidth SG [kHz]**	**Occupied Bandwidth Booster [kHz]**	**Delta Occupied Bandwidth [kHz]**	**Limit Delta Occupied Bandwidth [kHz]**	**Margin to Limit [kHz]**
Wideband	0.3 dB < AGC	2145.0	4389.0	4392.1	3.1	205.0	201.9
Wideband	3 dB > AGC	2145.0	4386.6	4390.9	4.3	205.0	200.7
Narrowband	0.3 dB < AGC	2146.0	316.8	313.5	3.4	10.0	6.6
Narrowband	3 dB > AGC	2146.0	319.4	313.8	5.5	10.0	4.5
Wideband 5G	0.3 dB < AGC	2145.0	45959	46006	47.2	2180	2133
Wideband 5G	3 dB > AGC	2145.0	46147	45979	168.7	2180	2011

Remark: Please see next sub-clause for the measurement plot.

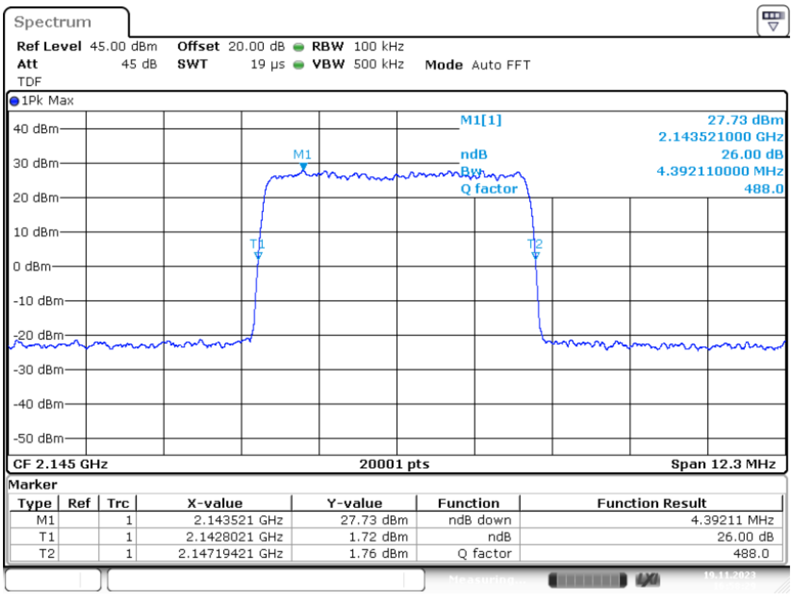
4.3.4 MEASUREMENT PLOT

Band: .AWS 1700; ANT 1; Frequency: 2.1450 GHz; Band Edge: mid; Mod: AWGN; Input OCBw 0.3 dB < AGC



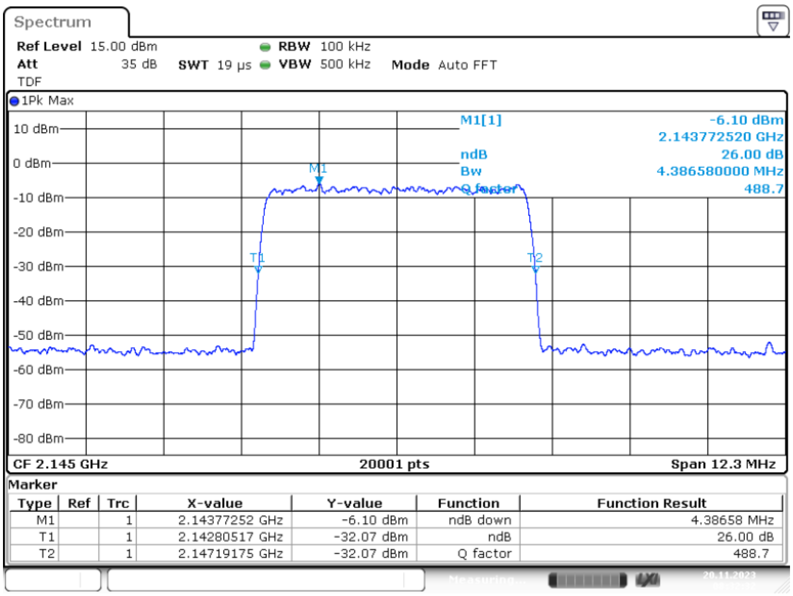
3.4 OCBw AWGN In-0.3 2.1450G _26dB

Band: .AWS 1700; ANT 1; Frequency: 2.1450 GHz; Band Edge: mid; Mod: AWGN; Output OCBw 0.3 dB < AGC



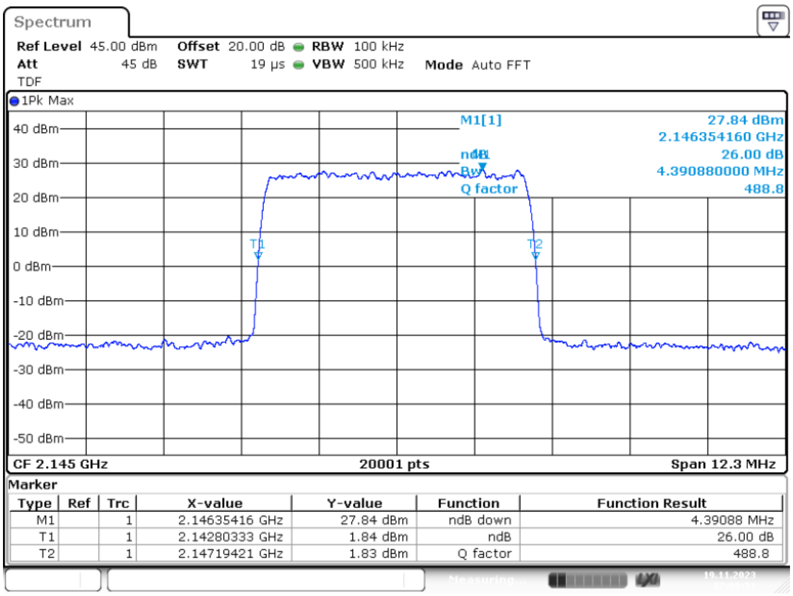
3.4 OCBw AWGN Out -0.3 2.1450G _26dB

Band: .AWS 1700; ANT 1; Frequency: 2.1450 GHz; Band Edge: mid; Mod: AWGN; Input OCBw 3 dB > AGC



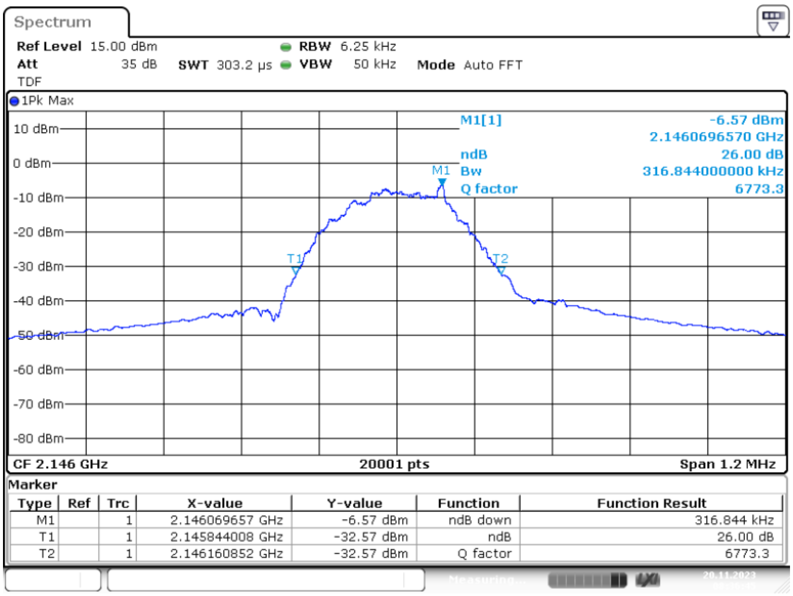
3.4 OCBw AWGN In+3 2.1450G _26dB

Band: .AWS 1700; ANT 1; Frequency: 2.1450 GHz; Band Edge: mid; Mod: AWGN; Output OCBw 3 dB > AGC



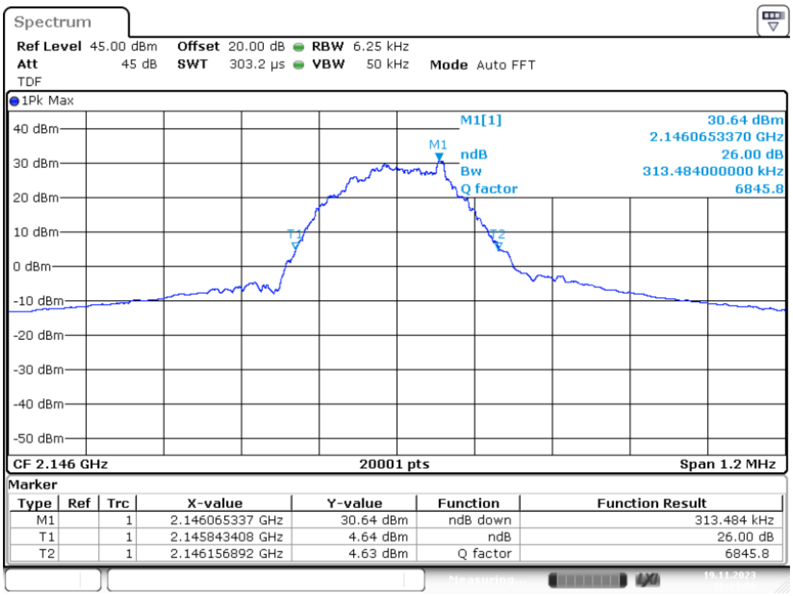
3.4 OCBw AWGN Out +3 2.1450G _26dB

Band: .AWS 1700; ANT 1; Frequency: 2.1460 GHz; Band Edge: mid; Mod: GSM; Input OCBw 0.3 dB < AGC



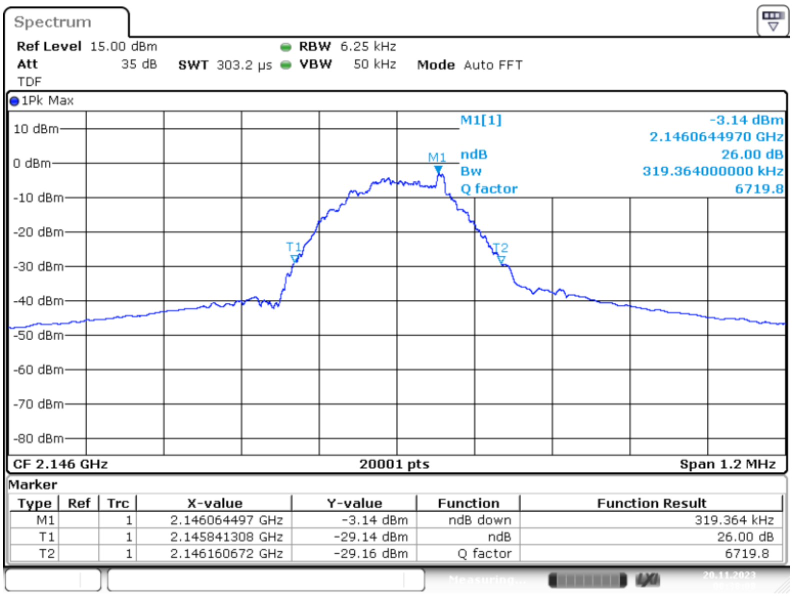
3.4 OCBw GSM In-0.3 2.1460G _26dB

Band: .AWS 1700; ANT 1; Frequency: 2.1460 GHz; Band Edge: mid; Mod: GSM; Output OCBw 0.3 dB < AGC



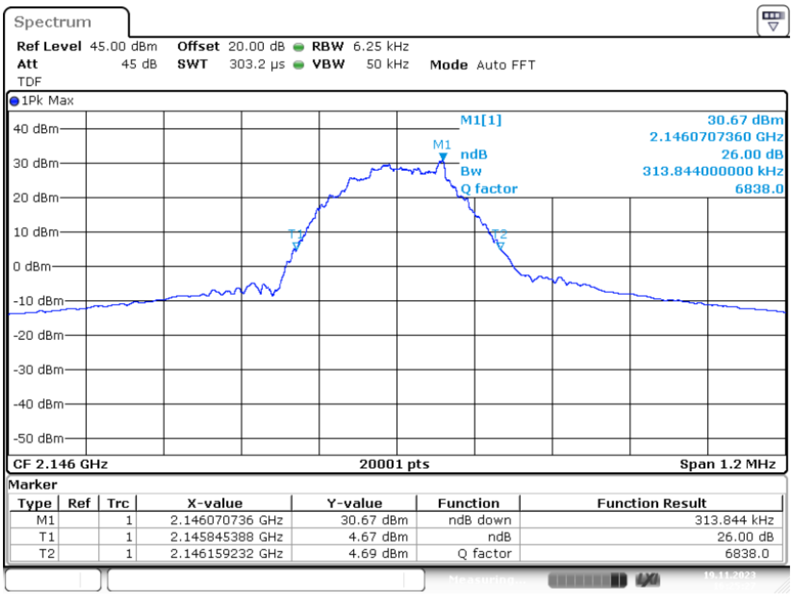
3.4 OCBw GSM Out -0.3 2.1460G _26dB

Band: .AWS 1700; ANT 1; Frequency: 2.1460 GHz; Band Edge: mid; Mod: GSM; Input OCBw 3 dB > AGC



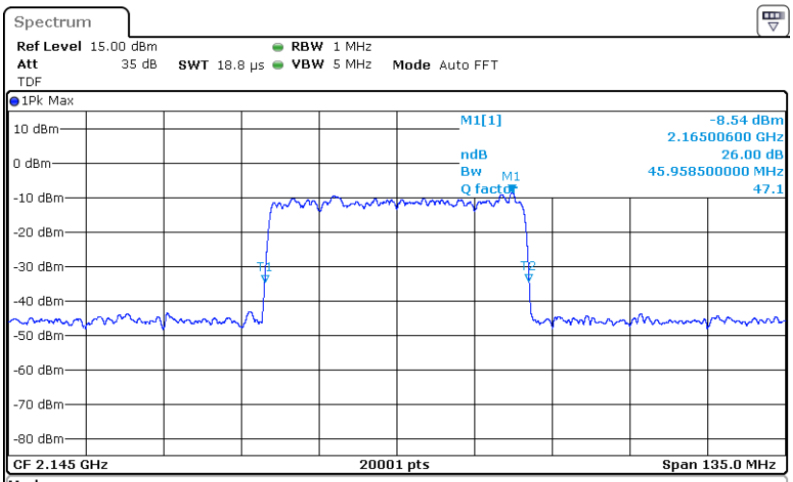
3.4 OCBw GSM In+3 2.1460G _26dB

Band: .AWS 1700; ANT 1; Frequency: 2.1460 GHz; Band Edge: mid; Mod: GSM; Output OCBw 3 dB > AGC



3.4 OCBw GSM Out +3 2.1460G _26dB

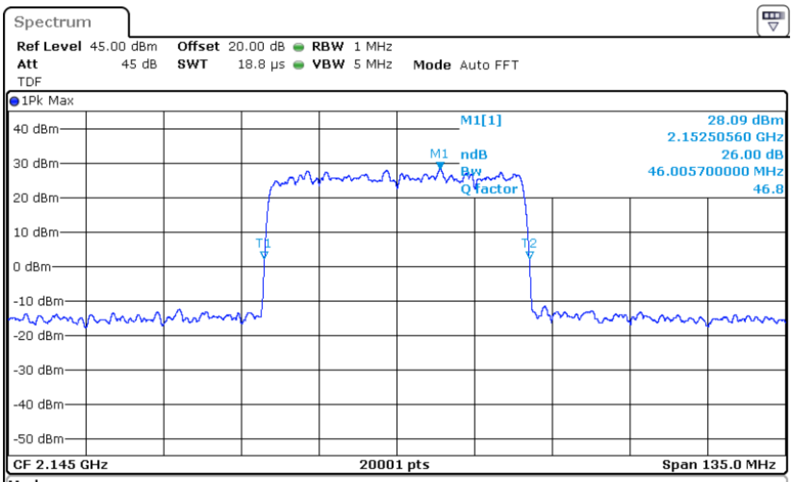
Band: .AWS 1700; ANT 1; Frequency: 2.1450 GHz; Band Edge: mid; Mod: AWGN 45M; Input OCBw 0.3 dB < AGC



Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.165006 GHz	-8.54 dBm	ndB down	45.9585 MHz
T1		1	2.1220174 GHz	-34.60 dBm	ndB	26.00 dB
T2		1	2.1679759 GHz	-34.49 dBm	Q factor	47.1

3.4 OCBw AWGN 45M In-0.3 2.1450G _26dB

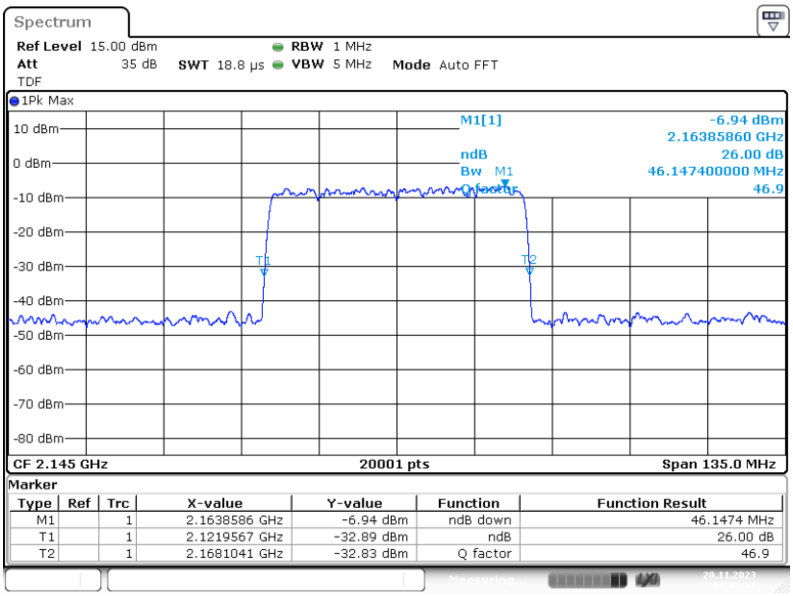
Band: .AWS 1700; ANT 1; Frequency: 2.1450 GHz; Band Edge: mid; Mod: AWGN 45M; Output OCBw 0.3 dB < AGC



Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.1525056 GHz	28.09 dBm	ndB down	46.0057 MHz
T1		1	2.1219904 GHz	2.17 dBm	ndB	26.00 dB
T2		1	2.1679961 GHz	2.15 dBm	Q factor	46.8

3.4 OCBw AWGN 45M Out -0.3 2.1450G _26dB

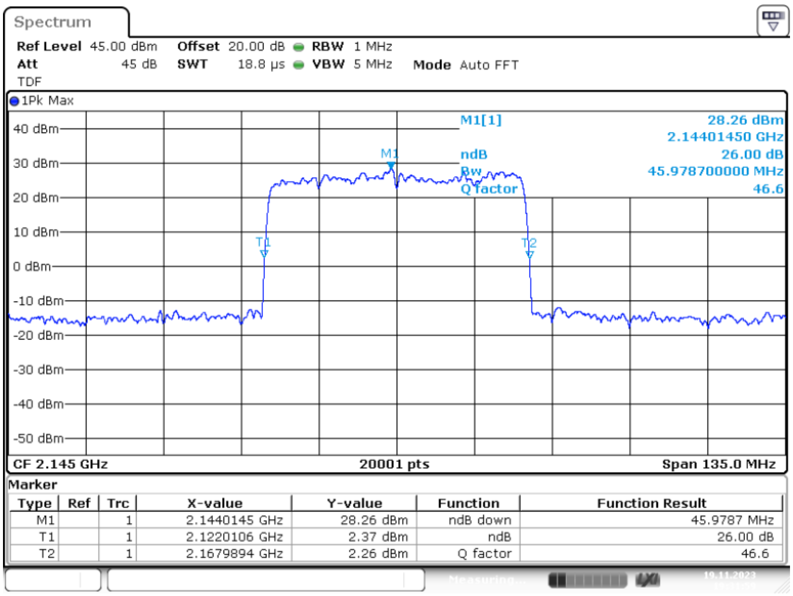
Band: .AWS 1700; ANT 1; Frequency: 2.1450 GHz; Band Edge: mid; Mod: AWGN 45M; Input OCBw 3 dB > AGC



Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.1638586 GHz	-6.94 dBm	ndB down	46.1474 MHz
T1		1	2.1219567 GHz	-32.89 dBm	ndB	26.00 dB
T2		1	2.1681041 GHz	-32.83 dBm	Q factor	46.9

3.4 OCBw AWGN 45M In+3 2.1450G _26dB

Band: .AWS 1700; ANT 1; Frequency: 2.1450 GHz; Band Edge: mid; Mod: AWGN 45M; Output OCBw 3 dB > AGC



Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.1440145 GHz	28.26 dBm	ndB down	45.9787 MHz
T1		1	2.1220106 GHz	2.37 dBm	ndB	26.00 dB
T2		1	2.1679894 GHz	2.26 dBm	Q factor	46.6

3.4 OCBw AWGN 45M Out +3 2.1450G _26dB

4.3.5 TEST EQUIPMENT USED

- Conducted

4.4 CONDUCTED SPURIOUS EMISSIONS AT ANTENNA TERMINALS

Standard FCC Part § 2.1051, § 27.53

The test was performed according to:
ANSI C63.26, KDB 935210 D05 v01r04: 3.6

Test date: 2023-12-07

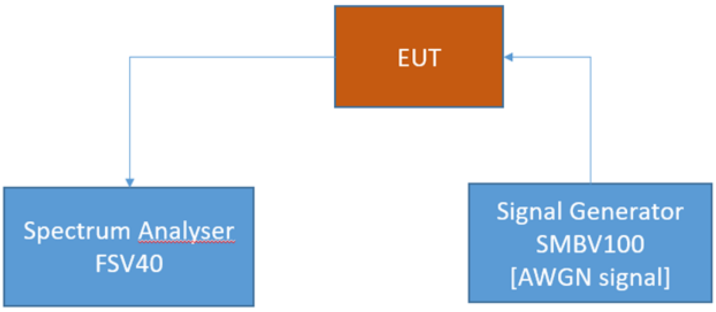
Environmental conditions: 23 °C ± 5 K; 40 % r. F. ± 20 % r. F.

Test engineer: Thomas Hufnagel

4.4.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the signal booster power and gain limits and requirements for industrial signal boosters.

The EUT was connected to the test setup according to the following diagram:



FCC Part 22/24/27/90 Industrial signal booster – Test Setup; RF Output Power / Gain

The attenuation of the measuring and stimulus path are known for each measured frequency and are considered.

The Spectrum Analyzer settings can be directly found in the measurement diagrams.

4.4.2 TEST REQUIREMENTS/LIMITS

Abstract § 2.1051 from FCC:

FCC Part 2.1051; Measurement required: Spurious emissions at antenna terminal:

The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in § 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

Part 27; Miscellaneous Wireless Communication Services

Subpart C – Technical standards

§27.53 – Emission limits

Abstract § 27.53 FCC:

(h) AWS emission limits—(1) General protection levels. Except as otherwise specified below, for operations in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz, and 2180-2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least 43 + 10 log10 (P) dB.

4.4.3 TEST PROTOCOL

General considerations concerning the limits:

The measuring bandwidth of 1 MHz was chosen according the test requirements exept at the band edges: At the band edges reducing of measurement bandwidth was necessary to prevent overlaying the RF-signal over the spurious emissions.
Also outside the Downlink frequency band at lower frequencies the measurement bandwidths were reduced to have the possibility to record the spurious emissions at these lower frequencies.

At frequencies were measuring bandwidths were reduced also the limit lines were reduced acoording the given formula:

$$p\ RBWreduced\ [dBm] = 10 * \log\left(RBWreduced\ [kHz] — 1000\ kHz\right) + pRBW\ 1000\ kHz[dBm]$$

Hereby “p” are the limit lines’ values.

Band 66, AWS 1700, downlink							
Test Frequency	**Signal Type**	**Spurious Freq. [MHz]**	**Spurious Level [dBm]**	**Detector**	**RBW [kHz]**	**Limit [dBm]**	**Margin to Limit [dB]**
low	Wideband	0.00902	-55.8	RMS	1	-43.0	12.8
low	Wideband	0.09249	-52.0	RMS	10	-33.0	19.0
low	Wideband	949.3	-38.0	RMS	100	-23.0	15.0
low	Wideband	1944.8	-26.4	RMS	1000	-13.0	13.4
low	Wideband	2108.9	-37.8	RMS	100	-23.0	14.8
low	Wideband	2182.1	-40.7	RMS	100	-23.0	17.7
low	Wideband	4819.3	-28.2	RMS	1000	-13.0	15.2
low	Wideband	6986.6	-24.6	RMS	1000	-13.0	11.6
low	Wideband	19535.8	-29.7	RMS	1000	-13.0	16.7
low	Wideband	20291.7	-29.4	RMS	1000	-13.0	16.4
low	Wideband	30076.0	-29.1	RMS	1000	-13.0	16.1
mid	Wideband	0.01123	-56.4	RMS	1	-43.0	13.4
mid	Wideband	0.11749	-52.4	RMS	10	-33.0	19.4
mid	Wideband	948.8	-38.3	RMS	100	-23.0	15.3
mid	Wideband	1945.3	-24.4	RMS	1000	-13.0	11.4
mid	Wideband	2104.7	-40.7	RMS	100	-23.0	17.7
mid	Wideband	2185.8	-40.7	RMS	100	-23.0	17.7
mid	Wideband	4859.3	-28.3	RMS	1000	-13.0	15.3
mid	Wideband	6887.1	-24.4	RMS	1000	-13.0	11.4
mid	Wideband	19548.3	-30.0	RMS	1000	-13.0	17.0
mid	Wideband	20277.7	-29.6	RMS	1000	-13.0	16.6
mid	Wideband	30711.9	-29.1	RMS	1000	-13.0	16.1
high	Wideband	0.01123	-55.8	RMS	1	-43.0	12.8
high	Wideband	0.15748	-51.2	RMS	10	-33.0	18.2
high	Wideband	952.1	-38.4	RMS	100	-23.0	15.4
high	Wideband	1945.3	-26.7	RMS	1000	-13.0	13.7
high	Wideband	2103.7	-40.2	RMS	100	-23.0	17.2
high	Wideband	2181.3	-38.1	RMS	100	-23.0	15.1
high	Wideband	4552.8	-28.1	RMS	1000	-13.0	15.1
high	Wideband	6793.1	-24.3	RMS	1000	-13.0	11.3
high	Wideband	19534.8	-29.9	RMS	1000	-13.0	16.9
high	Wideband	20304.2	-29.5	RMS	1000	-13.0	16.5
high	Wideband	30869.4	-28.9	RMS	1000	-13.0	15.9

Band 66, AWS 1700, downlink

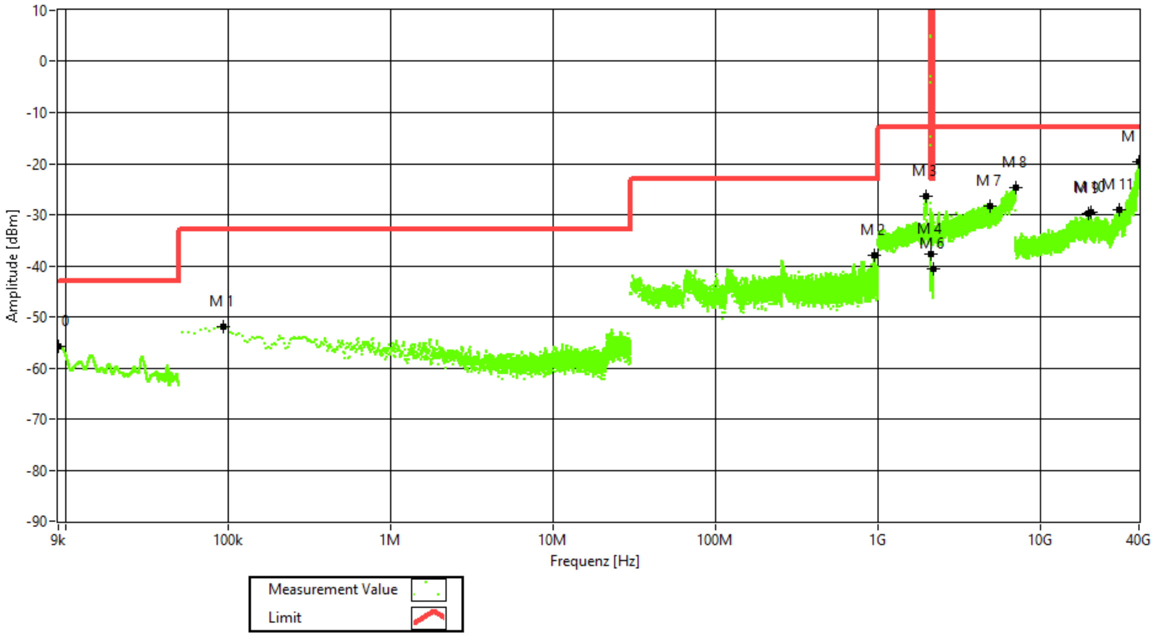
Test Frequency	Signal Type	Spurious Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Limit [dBm]	Margin to Limit [dB]
low	Narrowband	0.01439	-57.6	RMS	1	-43.0	14.6
low	Narrowband	0.05250	-51.7	RMS	10	-33.0	18.7
low	Narrowband	810.3	-38.8	RMS	100	-23.0	15.8
low	Narrowband	1962.3	-26.3	RMS	1000	-13.0	13.3
low	Narrowband	2102.0	-40.2	RMS	100	-23.0	17.2
low	Narrowband	2187.1	-41.7	RMS	100	-23.0	18.7
low	Narrowband	4910.3	-28.4	RMS	1000	-13.0	15.4
low	Narrowband	6973.1	-24.6	RMS	1000	-13.0	11.6
low	Narrowband	19542.3	-29.9	RMS	1000	-13.0	16.9
low	Narrowband	20304.7	-29.3	RMS	1000	-13.0	16.3
low	Narrowband	30729.9	-29.1	RMS	1000	-13.0	16.1
mid	Narrowband	0.00927	-55.9	RMS	1	-43.0	12.9
mid	Narrowband	0.09749	-52.1	RMS	10	-33.0	19.1
mid	Narrowband	949.5	-37.5	RMS	100	-23.0	14.5
mid	Narrowband	1945.3	-25.7	RMS	1000	-13.0	12.7
mid	Narrowband	2101.9	-40.4	RMS	100	-23.0	17.4
mid	Narrowband	2181.5	-41.4	RMS	100	-23.0	18.4
mid	Narrowband	4932.3	-28.0	RMS	1000	-13.0	15.0
mid	Narrowband	6951.6	-24.8	RMS	1000	-13.0	11.8
mid	Narrowband	19553.3	-29.5	RMS	1000	-13.0	16.5
mid	Narrowband	20303.2	-29.5	RMS	1000	-13.0	16.5
mid	Narrowband	30750.4	-28.6	RMS	1000	-13.0	15.6
high	Narrowband	0.01746	-57.1	RMS	1	-43.0	14.1
high	Narrowband	0.05250	-51.6	RMS	10	-33.0	18.6
high	Narrowband	814.8	-38.4	RMS	100	-23.0	15.4
high	Narrowband	1945.3	-25.1	RMS	1000	-13.0	12.1
high	Narrowband	2101.6	-40.9	RMS	100	-23.0	17.9
high	Narrowband	2181.6	-41.2	RMS	100	-23.0	18.2
high	Narrowband	4983.3	-27.8	RMS	1000	-13.0	14.8
high	Narrowband	6999.1	-24.8	RMS	1000	-13.0	11.8
high	Narrowband	19942.3	-29.9	RMS	1000	-13.0	16.9
high	Narrowband	20279.7	-29.8	RMS	1000	-13.0	16.8
high	Narrowband	30031.5	-28.4	RMS	1000	-13.0	15.4

Band 66, AWS 1700, downlink							
Test Frequency	Signal Type	Spurious Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Limit [dBm]	Margin to Limit [dB]
low	Wideband 5G	0.03024	-57.1	RMS	1	-43.0	14.1
low	Wideband 5G	0.06250	-51.2	RMS	10	-33.0	18.2
low	Wideband 5G	951.0	-37.8	RMS	100	-23.0	14.8
low	Wideband 5G	1944.8	-25.6	RMS	1000	-13.0	12.6
low	Wideband 5G	2103.9	-39.7	RMS	100	-23.0	16.7
low	Wideband 5G	2181.6	-39.2	RMS	100	-23.0	16.2
low	Wideband 5G	4719.3	-27.8	RMS	1000	-13.0	14.8
low	Wideband 5G	6963.6	-24.5	RMS	1000	-13.0	11.5
low	Wideband 5G	19967.8	-29.7	RMS	1000	-13.0	16.7
low	Wideband 5G	20297.2	-29.7	RMS	1000	-13.0	16.7
low	Wideband 5G	30758.9	-28.9	RMS	1000	-13.0	15.9
mid	Wideband 5G	0.00902	-57.6	RMS	1	-43.0	14.6
mid	Wideband 5G	0.05250	-51.0	RMS	10	-33.0	18.0
mid	Wideband 5G	949.9	-38.6	RMS	100	-23.0	15.6
mid	Wideband 5G	1945.3	-24.5	RMS	1000	-13.0	11.5
mid	Wideband 5G	2101.0	-39.8	RMS	100	-23.0	16.8
mid	Wideband 5G	2181.4	-40.4	RMS	100	-23.0	17.4
mid	Wideband 5G	4787.8	-27.7	RMS	1000	-13.0	14.7
mid	Wideband 5G	6901.1	-24.7	RMS	1000	-13.0	11.7
mid	Wideband 5G	19540.8	-30.0	RMS	1000	-13.0	17.0
mid	Wideband 5G	20320.7	-29.6	RMS	1000	-13.0	16.6
mid	Wideband 5G	31353.9	-29.0	RMS	1000	-13.0	16.0
high	Wideband 5G	0.01181	-56.7	RMS	1	-43.0	13.7
high	Wideband 5G	0.06250	-51.0	RMS	10	-33.0	18.0
high	Wideband 5G	950.9	-38.4	RMS	100	-23.0	15.4
high	Wideband 5G	1945.3	-24.7	RMS	1000	-13.0	11.7
high	Wideband 5G	2104.2	-38.8	RMS	100	-23.0	15.8
high	Wideband 5G	2187.7	-40.0	RMS	100	-23.0	17.0
high	Wideband 5G	4919.3	-28.2	RMS	1000	-13.0	15.2
high	Wideband 5G	6841.6	-24.8	RMS	1000	-13.0	11.8
high	Wideband 5G	19862.3	-30.0	RMS	1000	-13.0	17.0
high	Wideband 5G	20315.2	-29.6	RMS	1000	-13.0	16.6
high	Wideband 5G	30797.9	-28.9	RMS	1000	-13.0	15.9

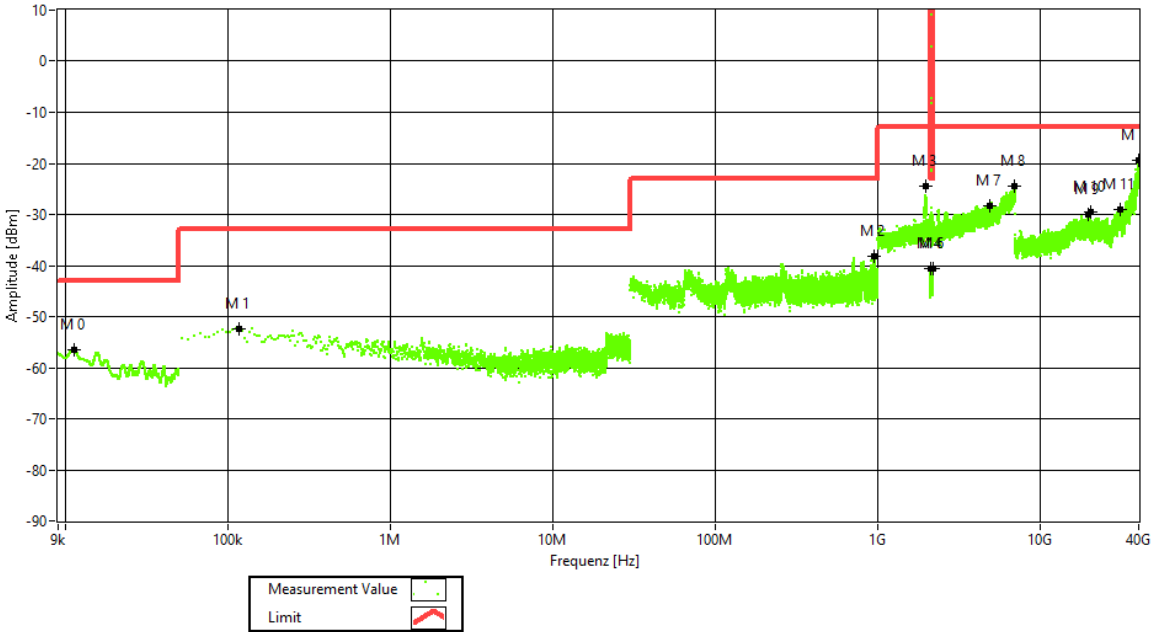
Remark: Please see next sub-clause for the measurement plot.

4.4.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE. "WORST CASE")

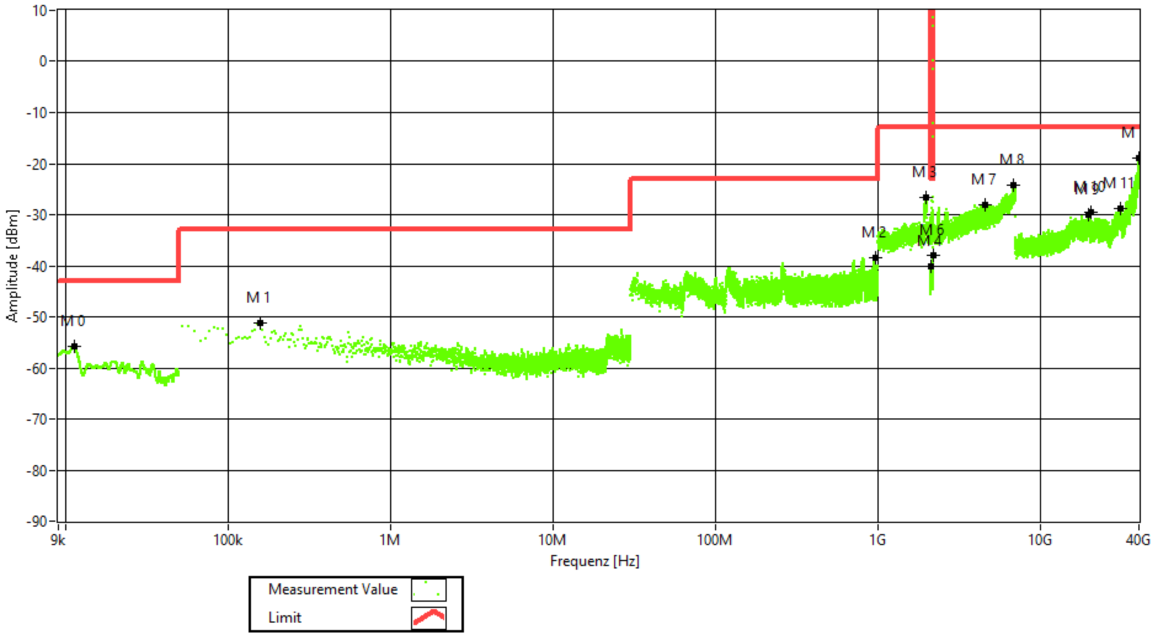
Frequency Band = Band 66 AWS 1700, ANT 1, Test Frequency = low, Direction = RF downlink, Signal Type = AWGN



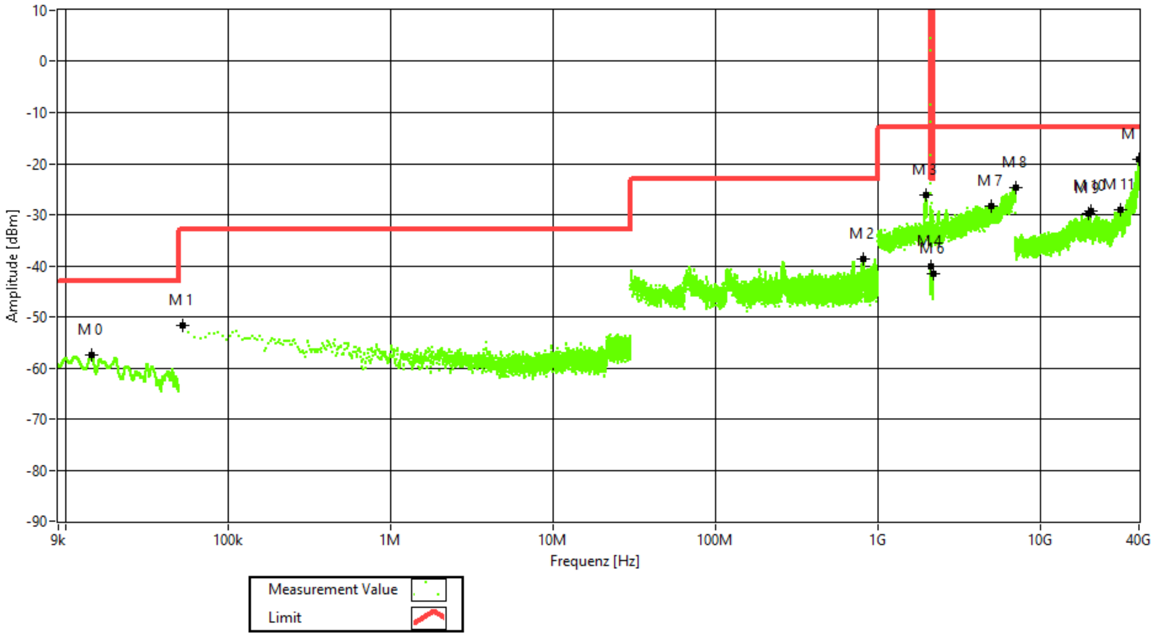
Frequency Band = Band 66 AWS 1700, ANT 1, Test Frequency = mid, Direction = RF downlink, Signal Type = AWGN



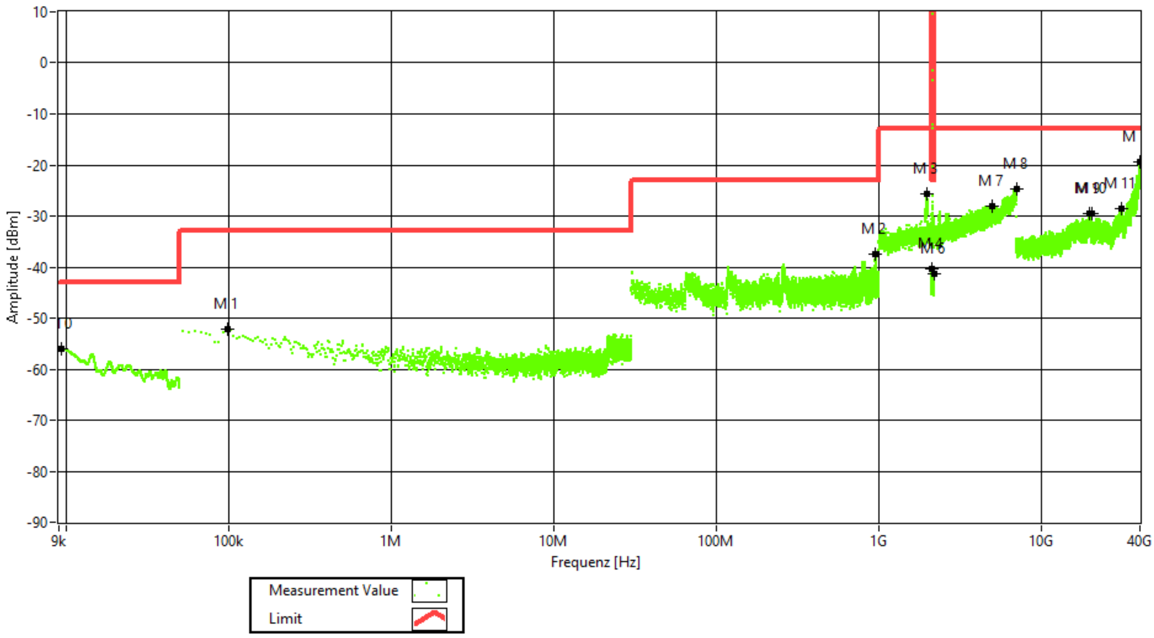
Frequency Band = Band 66 AWS 1700, ANT 1, Test Frequency = high, Direction = RF downlink,
Signal Type = AWGN



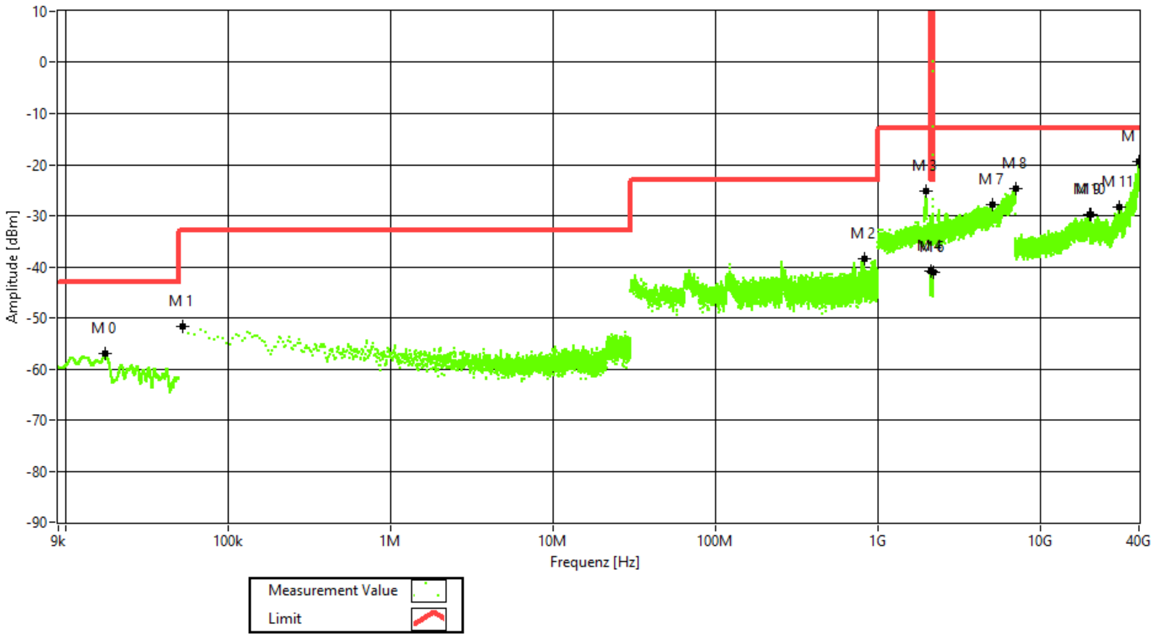
Frequency Band = Band 66 AWS 1700, ANT 1, Test Frequency = low, Direction = RF downlink, Signal Type = GSM



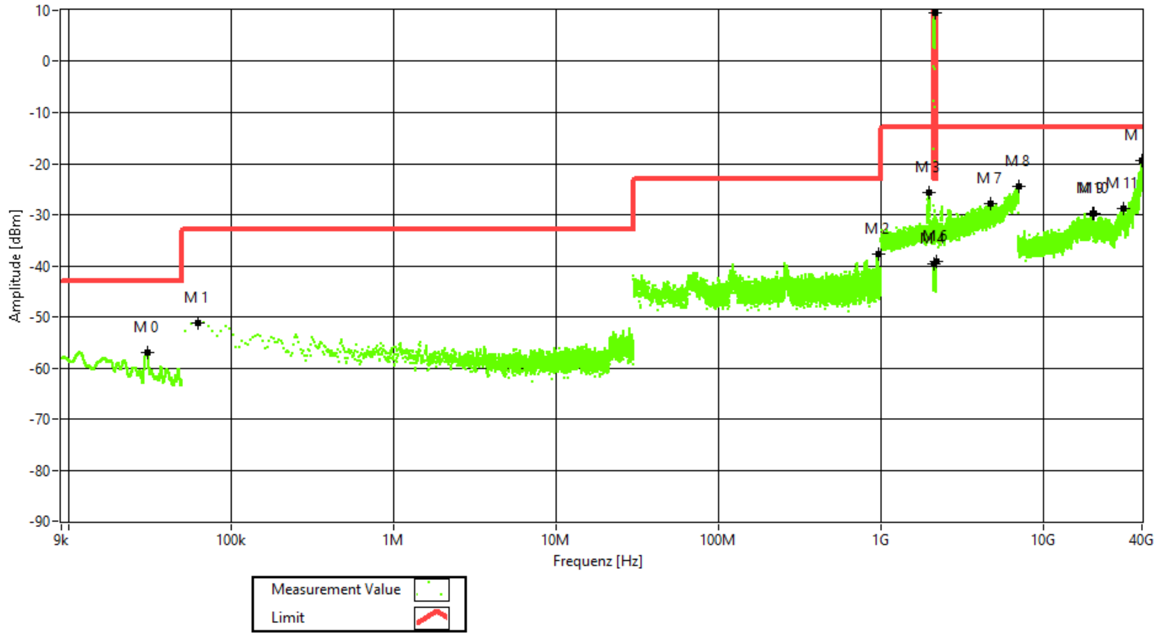
Frequency Band = Band 66 AWS 1700, ANT 1, Test Frequency = mid, Direction = RF downlink, Signal Type = GSM



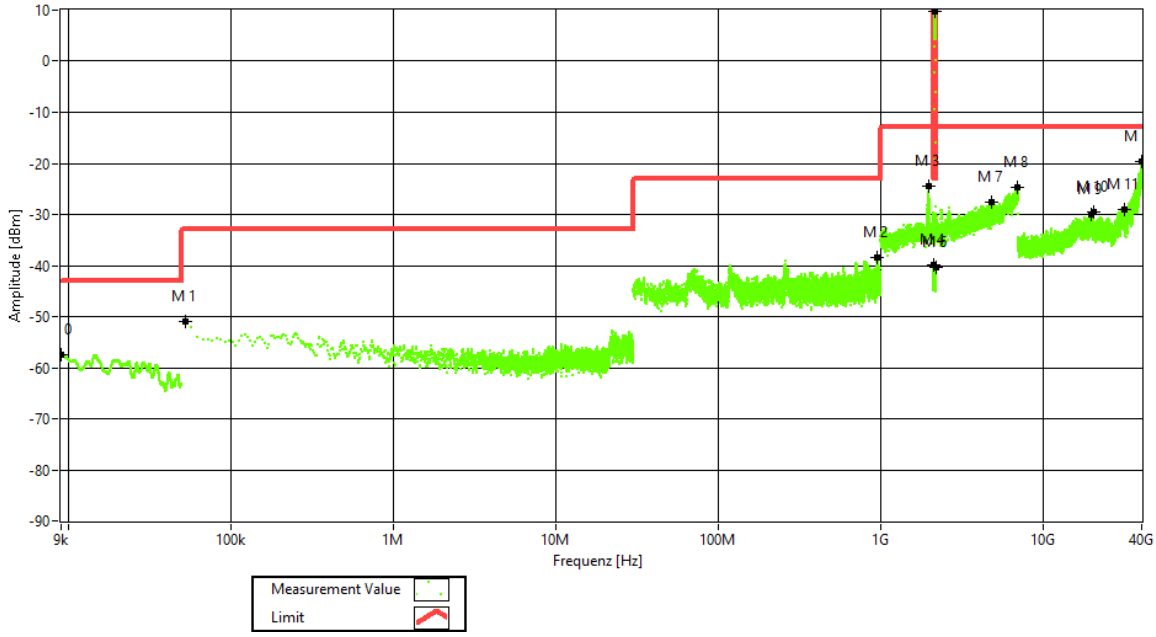
Frequency Band = Band 66 AWS 1700, ANT 1, Test Frequency = high, Direction = RF downlink,
Signal Type = GSM



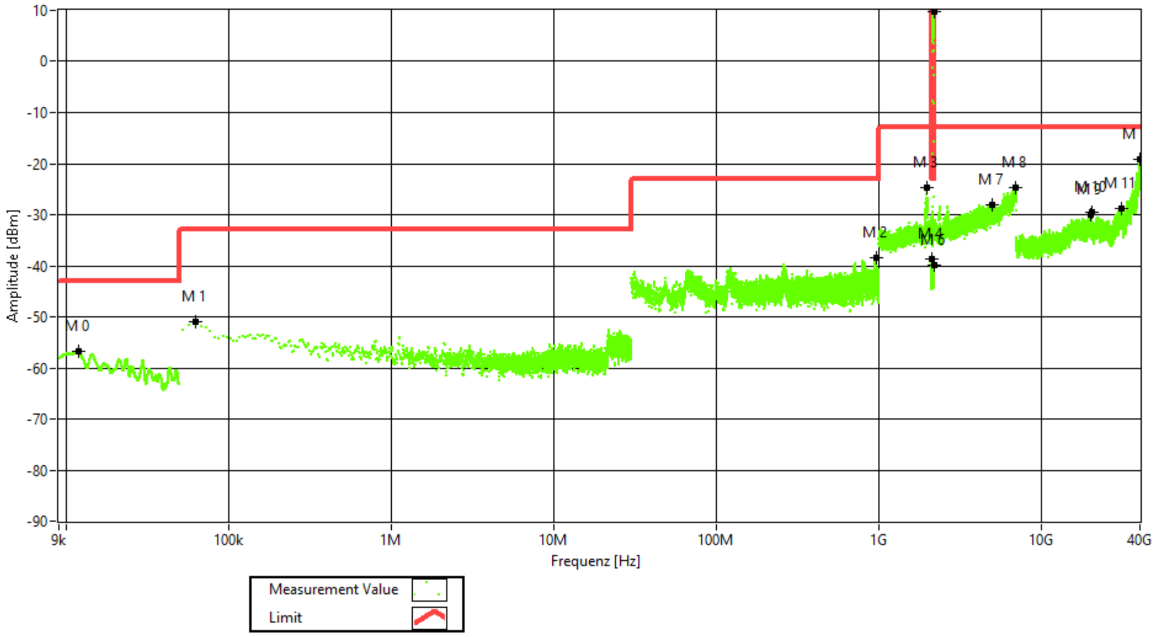
Frequency Band = Band 66 AWS 1700, ANT 1, Test Frequency = low, Direction = RF downlink, Signal Type = AWGN45



Frequency Band = Band 66 AWS 1700, ANT 1, Test Frequency = mid, Direction = RF downlink, Signal Type = AWGN45



Frequency Band = Band 66 AWS 1700, ANT 1, Test Frequency = high, Direction = RF downlink,
Signal Type = AWGN45



4.4.5 TEST EQUIPMENT USED

- Conducted

4.5 OUT-OF-BAND EMISSION LIMITS

Standard FCC Part § 2.1051, § 27.53

The test was performed according to:
ANSI C63.26, KDB 935210 D05 v01r04: 3.6

Test date: 2023-12-11 to 2023-12-12

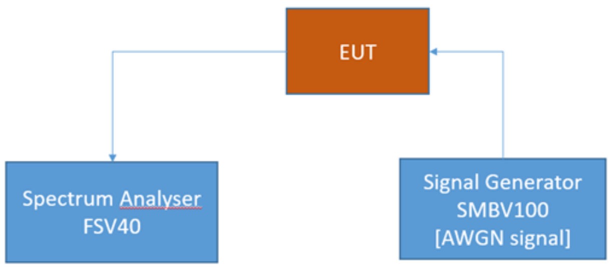
Environmental conditions: 23 °C ± 5 K; 40 % r. F. ± 20 % r. F.

Test engineer: Thomas Hufnagel

4.5.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the out-of-band emission limit for industrial signal boosters. The limits itself come from the applicable rule part for each operating band.

The EUT was connected to the test setup according to the following diagram:



FCC Part 22/24/27/90 Industrial signal booster – Test Setup; Out-of-band emissions

The attenuation of the measuring and stimulus path are known for each measured frequency and are considered.

The Spectrum Analyzer settings can be directly found in the measurement diagrams.

4.5.2 TEST REQUIREMENTS/LIMITS

Abstract § 2.1051 from FCC:

FCC Part 2.1051; Measurement required: Spurious emissions at antenna terminal:

The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in § 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

Part 27; Miscellaneous Wireless Communication Services

Subpart C – Technical standards

§27.53 – Emission limits

Abstract § 27.53 FCC:

(h) AWS emission limits—(1) General protection levels. Except as otherwise specified below, for operations in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz, and 2180-2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least 43 + 10 log10 (P) dB.

4.5.3 TEST PROTOCOL

Band 66 AWS 1700, downlink, Number of input signals = 1							
Signal Type	**Input Power**	**Band Edge**	**Signal Frequency [MHz]**	**Input Power [dBm]**	**Maximum Out-of-band Power [dBm]**	**Limit Out-of-band Power [dBm]**	**Margin to Limit [dB]**
Wideband	0.3 dB < AGC	upper	2177.5	-3.1	-35.3	-13.0	22.3
Wideband	3 dB > AGC	upper	2177.5	0.2	-35.3	-13.0	22.3
Wideband 5G	0.3 dB < AGC	upper	2157.5	-3.4	-30.1	-13.0	17.1
Wideband 5G	3 dB > AGC	upper	2157.5	-0.4	-29.9	-13.0	16.9
Narrowband	0.3 dB < AGC	upper	2179.8	-7.9	-27.6	-13.0	14.6
Narrowband	3 dB > AGC	upper	2179.8	-4.6	-27.0	-13.0	14
Wideband	0.3 dB < AGC	lower	2112.5	-3.7	-35.3	-13.0	22.3
Wideband	3 dB > AGC	lower	2112.5	-0.4	-35.3	-13.0	22.3
Wideband 5G	0.3 dB < AGC	lower	2132.5	-4.0	-30.2	-13.0	17.2
Wideband 5G	3 dB > AGC	lower	2132.5	-1.0	-29.9	-13.0	16.9
Narrowband	0.3 dB < AGC	lower	2110.2	-3.9	-28.7	-13.0	15.7
Narrowband	3 dB > AGC	lower	2110.2	-0.6	-27.4	-13.0	14.4

Band 66 AWS 1700, downlink, Number of input signals = 2								
Signal Type	**Input Power**	**Band Edge**	**Signal Frequency f1 [MHz]**	**Signal Frequency f2 [MHz]**	**Input Power [dBm]**	**Maximum Out-of-band Power [dBm]**	**Limit Out-of-band Power [dBm]**	**Margin to Limit [dB]**
Wideband	0.3 dB < AGC	upper	2177.5	2175.0	-3.3	-35.6	-13.0	22.6
Wideband	3 dB > AGC	upper	2177.5	2175.0	0.0	-35.9	-13.0	22.9
Narrowband	0.3 dB < AGC	upper	2179.8	2179.6	-2.3	-30.7	-13.0	17.7
Narrowband	3 dB > AGC	upper	2179.8	2179.6	1.0	-30.3	-13.0	17.3
Wideband	0.3 dB < AGC	lower	2112.5	2115.0	-3.7	-35.7	-13.0	22.7
Wideband	3 dB > AGC	lower	2132.5	2115.0	-0.4	-35.8	-13.0	22.8
Narrowband	0.3 dB < AGC	lower	2110.2	2110.4	-3.3	-30.5	-13.0	17.5
Narrowband	3 dB > AGC	lower	2110.2	2110.4	0.0	-30.1	-13.0	17.1

Remark: Please see next sub-clause for the measurement plot.

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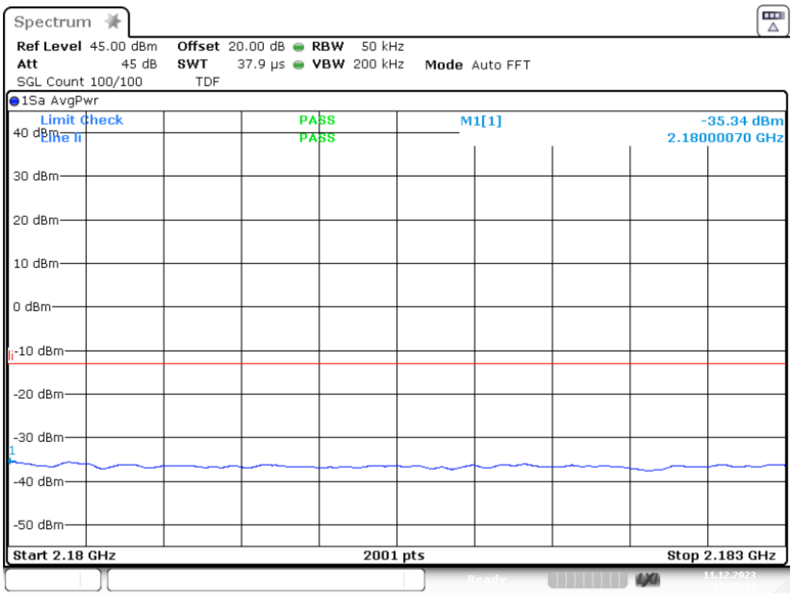
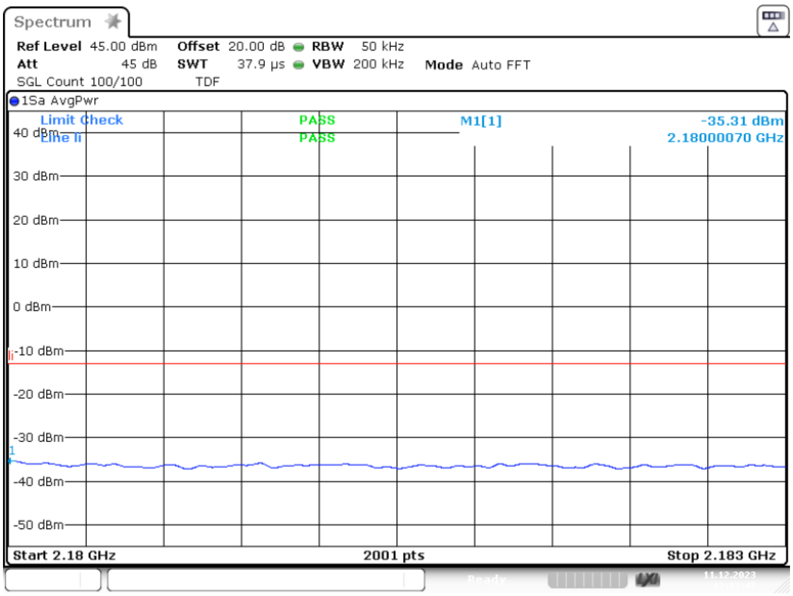
4.5.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

Band: .AWS 1700; ANT 1; Frequency: 2.1100 GHz to 2.1800 GHz; Band Edge: upper; Mod: AWGN; Input Power = 0.3 dB < AGC; Number of signals 1



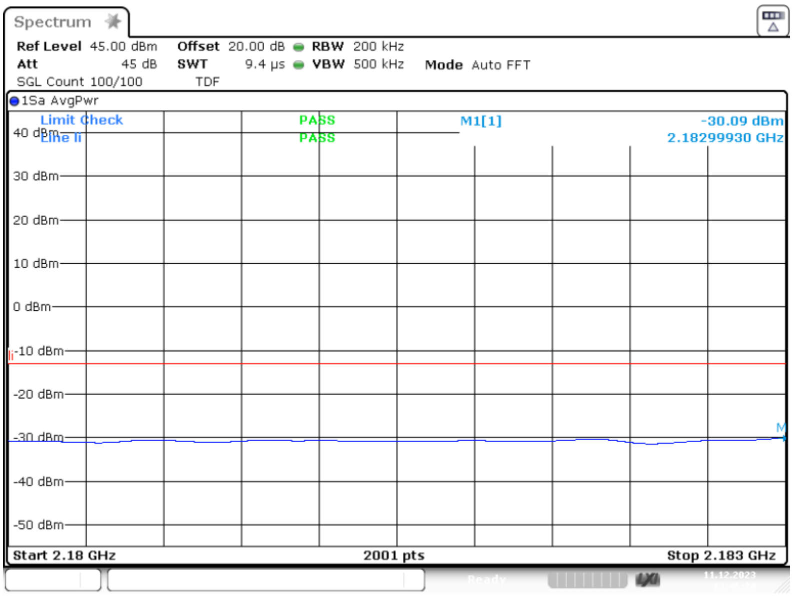
3.6.2 out of band emi AWS1700L AWGN upper 1carrier -0.3 dB 2
.180G 2.183G

Band: .AWS 1700; ANT 1; Frequency: 2.1100 GHz to 2.1800 GHz; Band Edge: upper; Mod: AWGN; Input Power = 3 dB > AGC; Number of signals 1



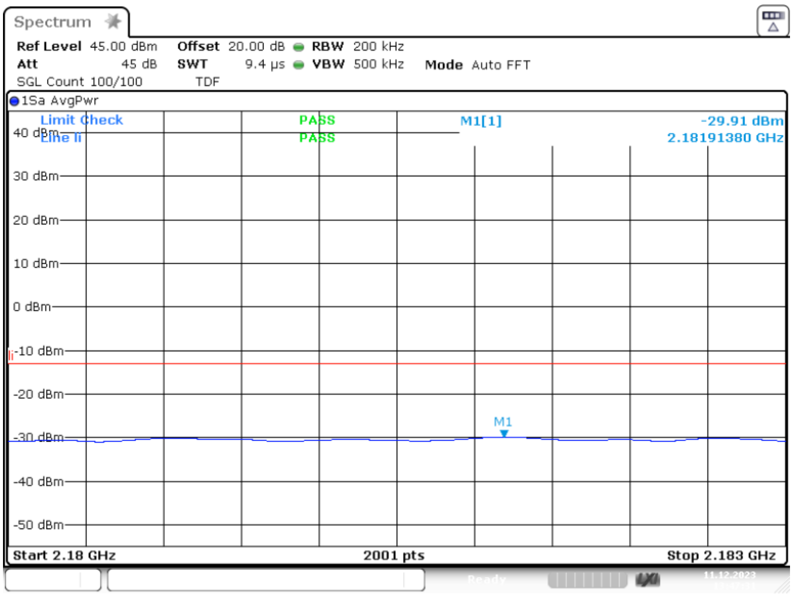
3.6.2 out of band emi AWS1700L AWGN upper 1carrier +3.0 dB 2
.180G 2.183G

Band: .AWS 1700; ANT 1; Frequency: 2.1100 GHz to 2.1800 GHz; Band Edge: upper; Mod: AWGN 45M; Input Power = 0.3 dB < AGC; Number of signals 1



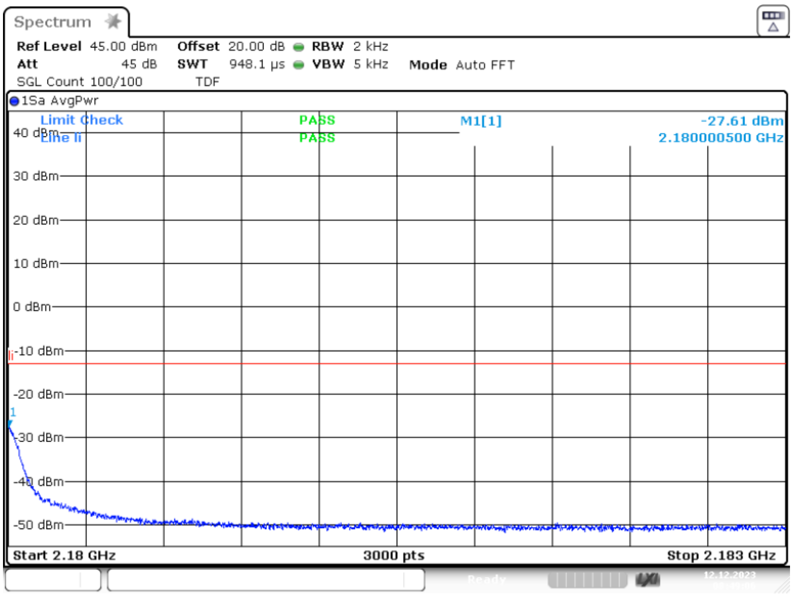
3.6.2 out of band emi AWS1700L AWGN 45M upper 1carrier -0.3 dB 2.180G 2.183G

Band: .AWS 1700; ANT 1; Frequency: 2.1100 GHz to 2.1800 GHz; Band Edge: upper; Mod: AWGN 45M; Input Power = 3 dB > AGC; Number of signals 1



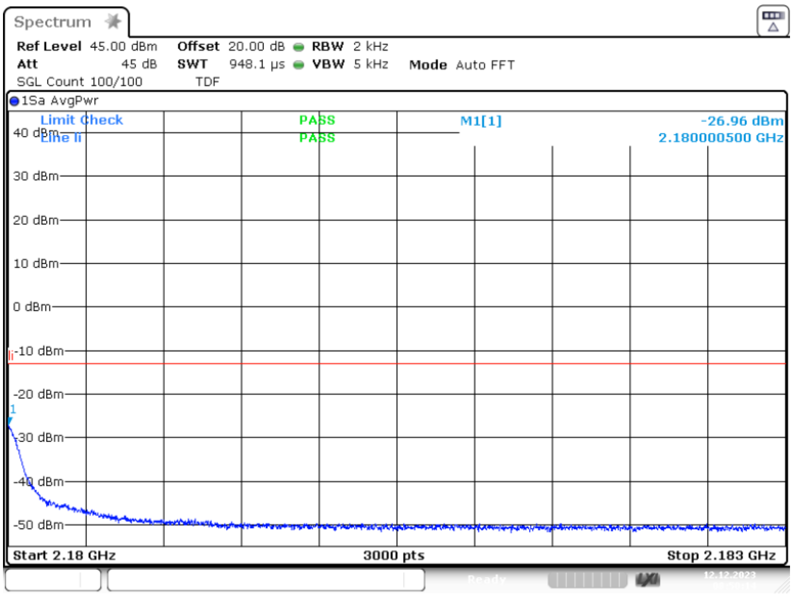
3.6.2 out of band emi AWS1700L AWGN 45M upper 1carrier +3.0 dB 2.180G 2.183G

Band: .AWS 1700; ANT 1; Frequency: 2.1100 GHz to 2.1800 GHz; Band Edge: upper; Mod: GSM; Input Power = 0.3 dB < AGC; Number of signals 1



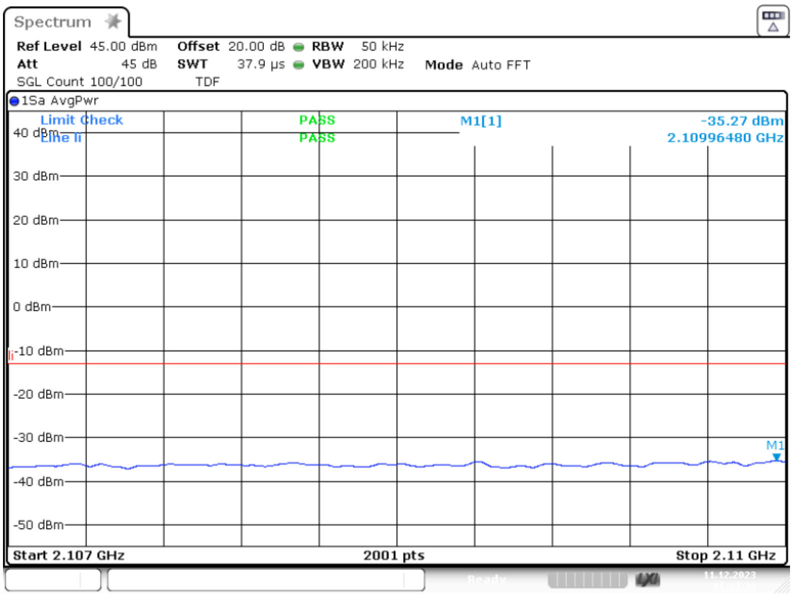
3.6.2 out of band emi AWS1700L GSM upper 1carrier -0.3 dB 2.
180G 2.183G

Band: .AWS 1700; ANT 1; Frequency: 2.1100 GHz to 2.1800 GHz; Band Edge: upper; Mod: GSM; Input Power = 3 dB > AGC; Number of signals 1



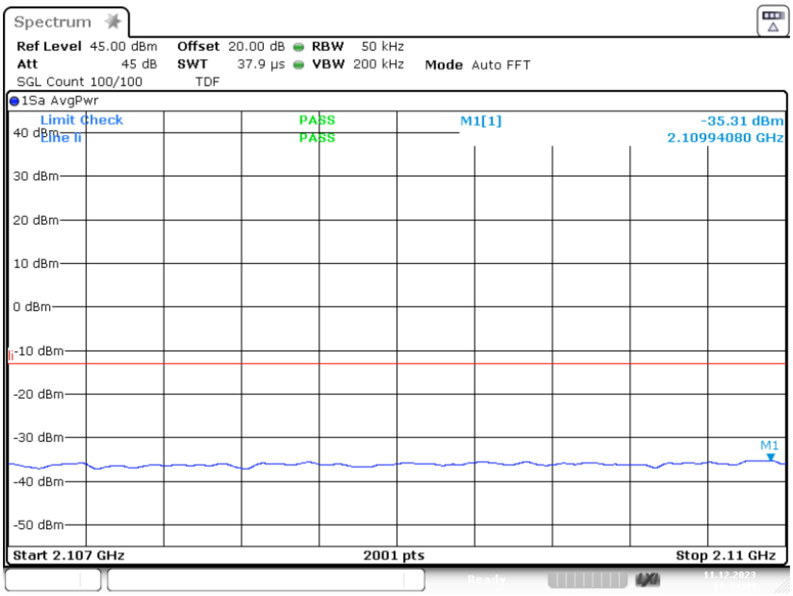
3.6.2 out of band emi AWS1700L GSM upper 1carrier +3.0 dB 2.
180G 2.183G

Band: .AWS 1700; ANT 1; Frequency: 2.1100 GHz to 2.1800 GHz; Band Edge: lower; Mod: AWGN; Input Power = 0.3 dB < AGC; Number of signals 1



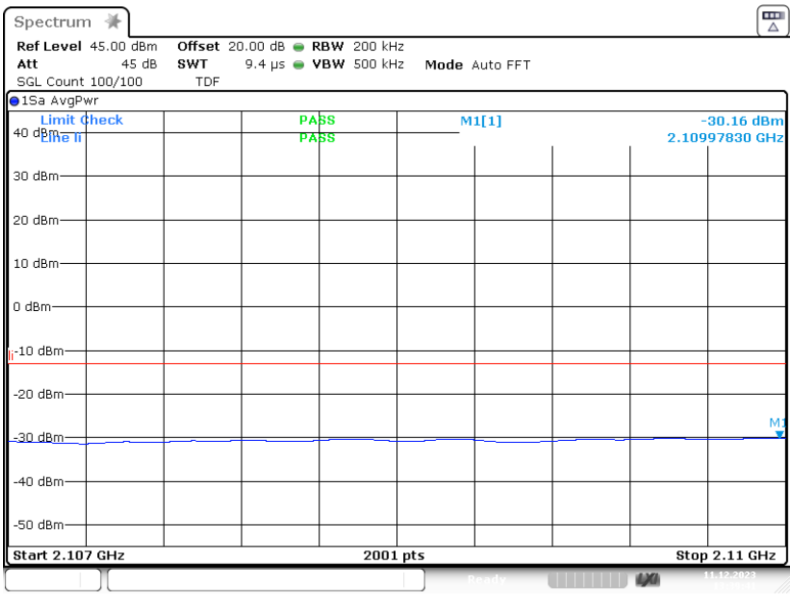
3.6.2 out of band emi AWS1700L AWGN lower 1carrier -0.3 dB 2
.107G 2.110G

Band: .AWS 1700; ANT 1; Frequency: 2.1100 GHz to 2.1800 GHz; Band Edge: lower; Mod: AWGN; Input Power = 3 dB > AGC; Number of signals 1



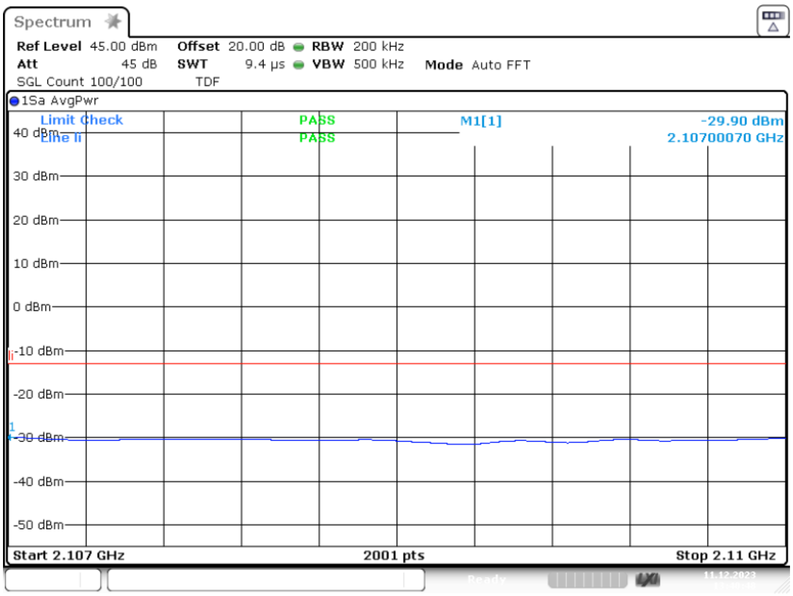
3.6.2 out of band emi AWS1700L AWGN lower 1carrier +3.0 dB 2
.107G 2.110G

Band: .AWS 1700; ANT 1; Frequency: 2.1100 GHz to 2.1800 GHz; Band Edge: lower; Mod: AWGN 45M; Input Power = 0.3 dB < AGC; Number of signals 1



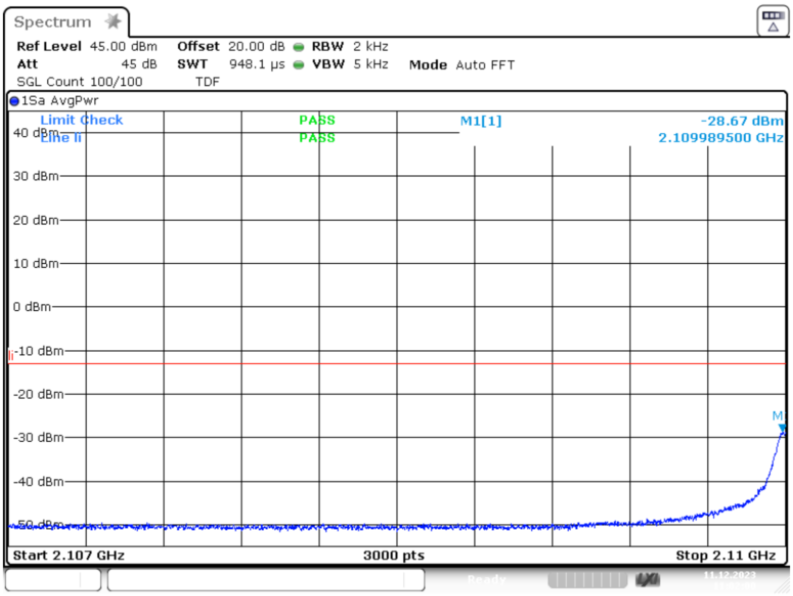
3.6.2 out of band emi AWS1700L AWGN 45M lower 1carrier -0.3 dB 2.107G 2.110G

Band: .AWS 1700; ANT 1; Frequency: 2.1100 GHz to 2.1800 GHz; Band Edge: lower; Mod: AWGN 45M; Input Power = 3 dB > AGC; Number of signals 1



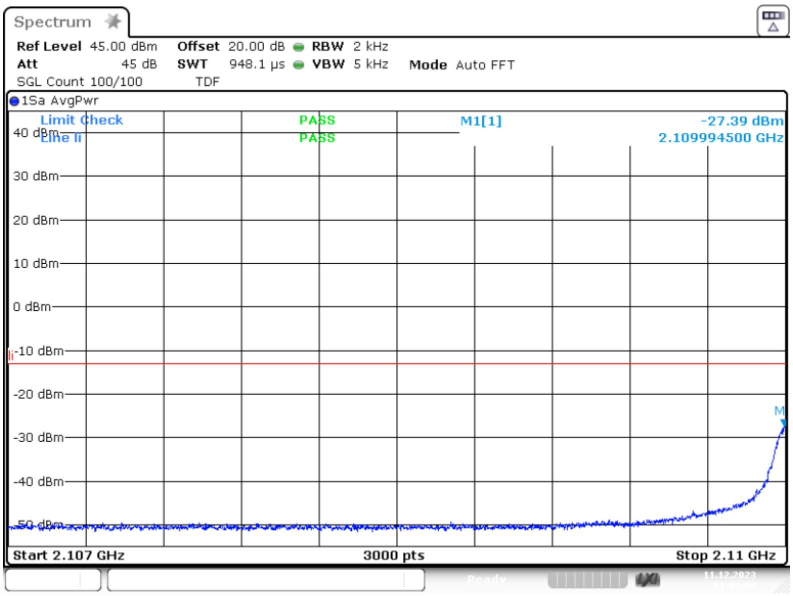
3.6.2 out of band emi AWS1700L AWGN 45M lower 1carrier +3.0 dB 2.107G 2.110G

Band: .AWS 1700; ANT 1; Frequency: 2.1100 GHz to 2.1800 GHz; Band Edge: lower; Mod: GSM; Input Power = 0.3 dB < AGC; Number of signals 1



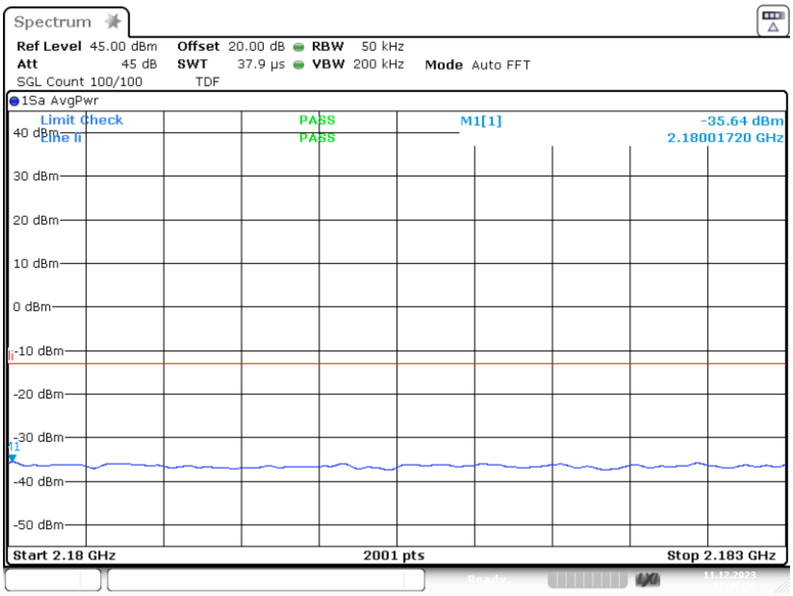
3.6.2 out of band emi AWS1700L GSM lower 1carrier -0.3 dB 2.
107G 2.110G

Band: .AWS 1700; ANT 1; Frequency: 2.1100 GHz to 2.1800 GHz; Band Edge: lower; Mod: GSM; Input Power = 3 dB > AGC; Number of signals 1



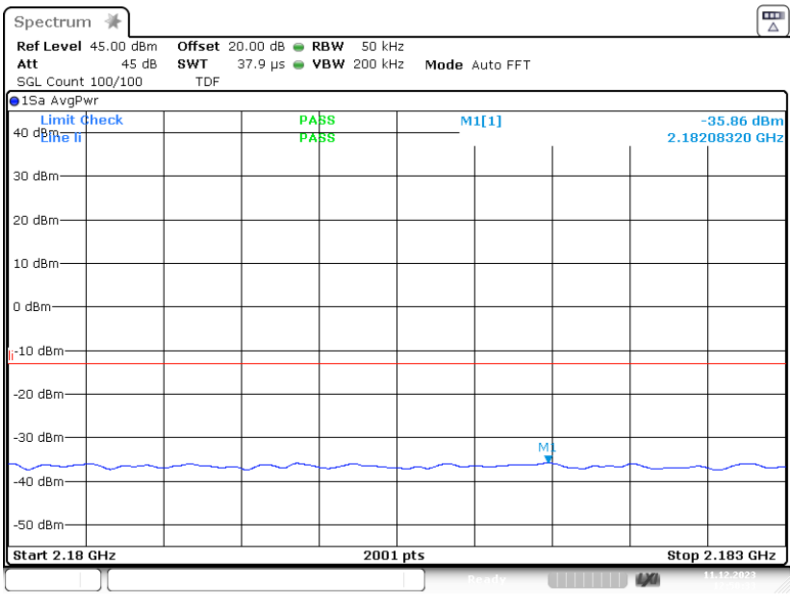
3.6.2 out of band emi AWS1700L GSM lower 1carrier +3.0 dB 2.
107G 2.110G

Band: .AWS 1700; ANT 1; Frequency: 2.1100 GHz to 2.1800 GHz; Band Edge: upper; Mod: AWGN; Input Power = 0.3 dB < AGC; Number of signals 2



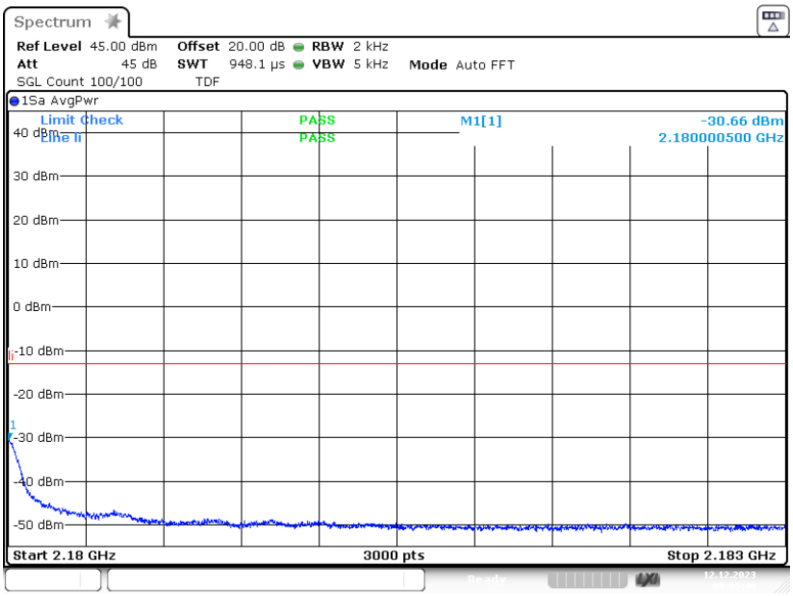
3.6.2 out of band emi AWS1700L AWGN upper 2carriers -0.3 dB
2.180G 2.183G

Band: .AWS 1700; ANT 1; Frequency: 2.1100 GHz to 2.1800 GHz; Band Edge: upper; Mod: AWGN; Input Power = 3 dB > AGC; Number of signals 2



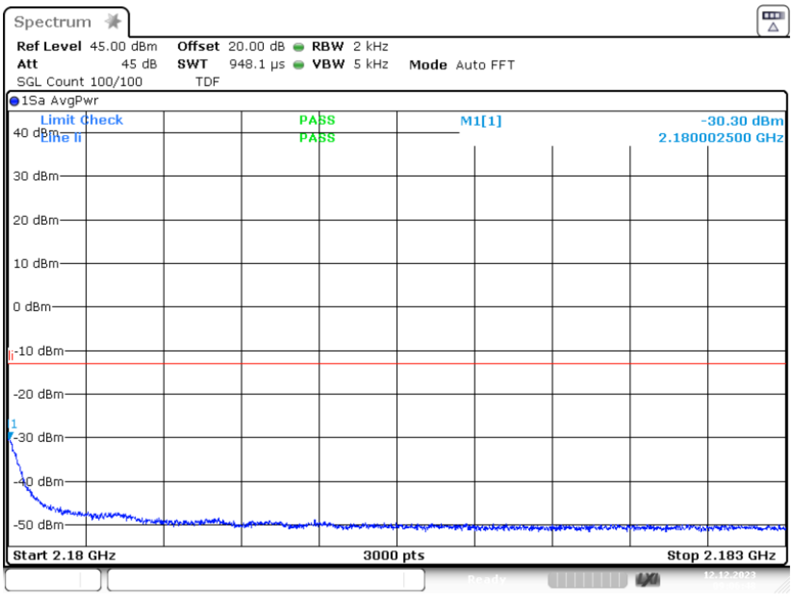
3.6.2 out of band emi AWS1700L AWGN upper 2carriers +3.0 dB
2.180G 2.183G

Band: .AWS 1700; ANT 1; Frequency: 2.1100 GHz to 2.1800 GHz; Band Edge: upper; Mod: GSM; Input Power = 0.3 dB < AGC; Number of signals 2



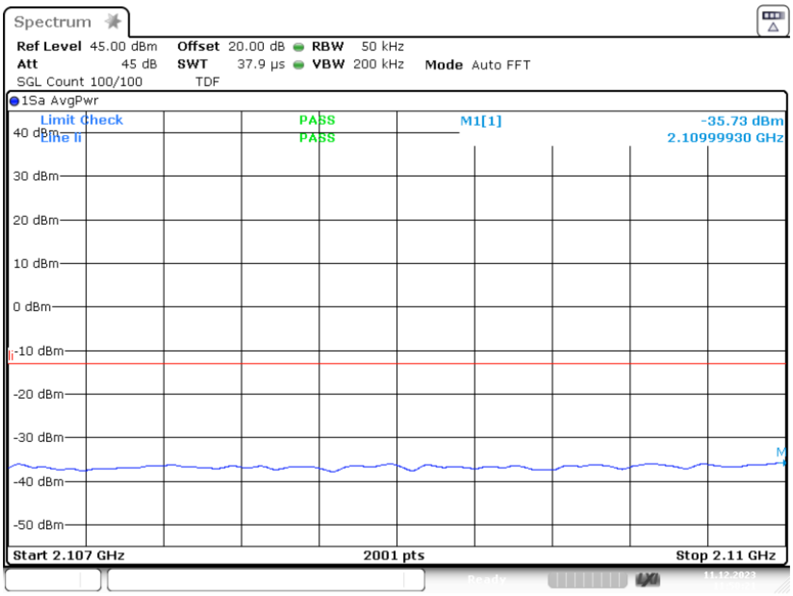
3.6.2 out of band emi AWS1700L GSM upper 2carriers -0.3 dB 2
.180G 2.183G

Band: .AWS 1700; ANT 1; Frequency: 2.1100 GHz to 2.1800 GHz; Band Edge: upper; Mod: GSM; Input Power = 3 dB > AGC; Number of signals 2



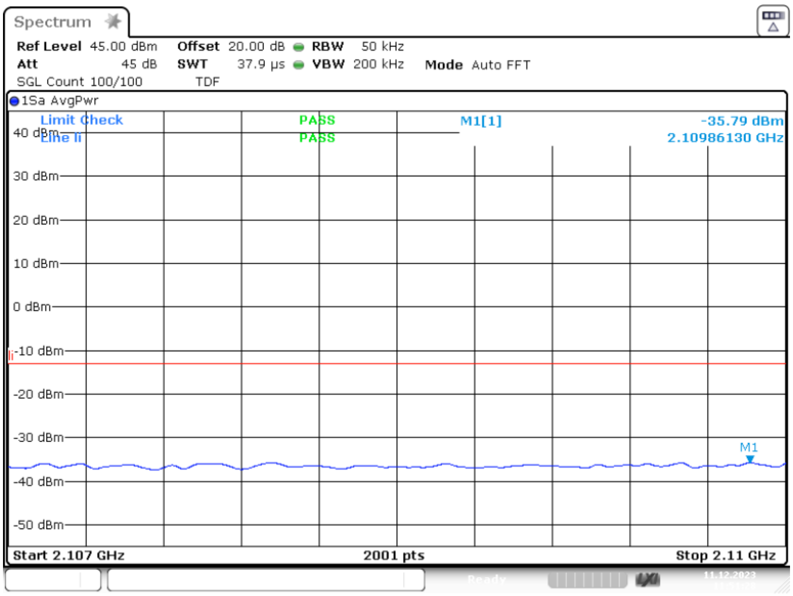
3.6.2 out of band emi AWS1700L GSM upper 2carriers +3.0 dB 2
.180G 2.183G

Band: .AWS 1700; ANT 1; Frequency: 2.1100 GHz to 2.1800 GHz; Band Edge: lower; Mod: AWGN; Input Power = 0.3 dB < AGC; Number of signals 2



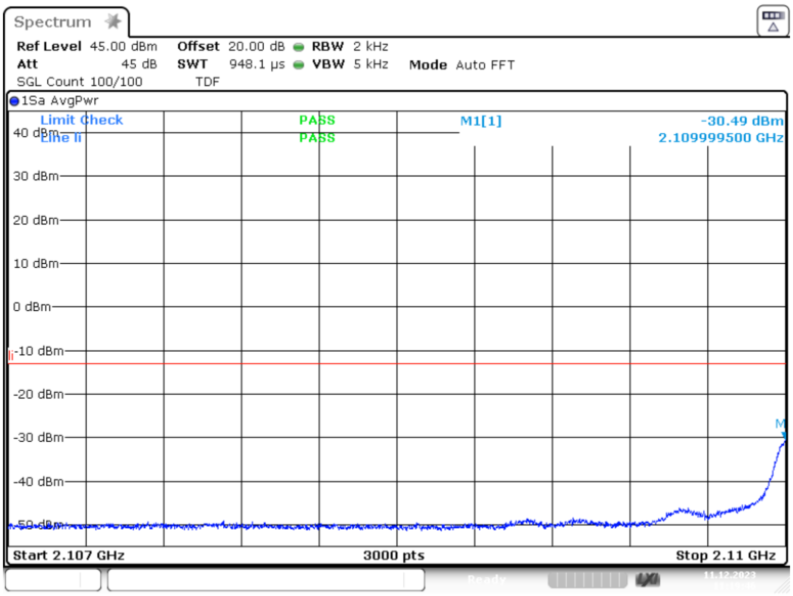
3.6.2 out of band emi AWS1700L AWGN lower 2carriers -0.3 dB
2.107G 2.110G

Band: .AWS 1700; ANT 1; Frequency: 2.1100 GHz to 2.1800 GHz; Band Edge: lower; Mod: AWGN; Input Power = 3 dB > AGC; Number of signals 2



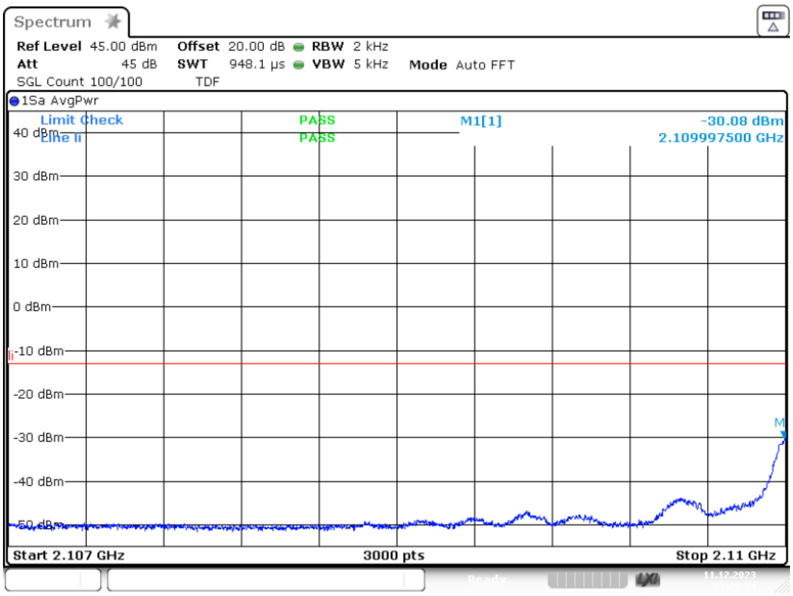
3.6.2 out of band emi AWS1700L AWGN lower 2carriers +3.0 dB
2.107G 2.110G

Band: .AWS 1700; ANT 1; Frequency: 2.1100 GHz to 2.1800 GHz; Band Edge: lower; Mod: GSM; Input Power = 0.3 dB < AGC; Number of signals 2



3.6.2 out of band emi AWS1700L GSM lower 2carriers -0.3 dB 2
.107G 2.110G

Band: .AWS 1700; ANT 1; Frequency: 2.1100 GHz to 2.1800 GHz; Band Edge: lower; Mod: GSM; Input Power = 3 dB > AGC; Number of signals 2



3.6.2 out of band emi AWS1700L GSM lower 2carriers +3.0 dB 2
.107G 2.110G

TEST EQUIPMENT USED

- Conducted

4.6 OUT-OF-BAND REJECTION

Standard KDB 935210 D05

The test was performed according to:
ANSI C63.26; KDB 935210 D05

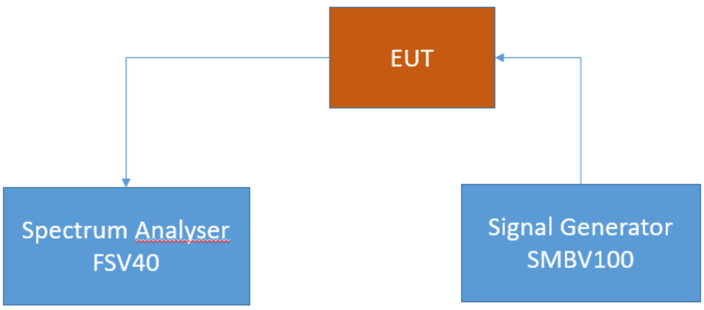
Test date: 2023-11-19

Environmental conditions: 23 °C ± 5 K; 40 % r. F. ± 20 % r. F.

Test engineer: Thomas Hufnagel

4.6.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the out-of-band rejection test case for industrial signal boosters.
The EUT was connected to the test setup according to the following diagram:



FCC Part 22/24/27/90 Industrial signal booster – Test Setup; Out-of-band rejection

The attenuation of the measuring and stimulus path are known for each measured frequency and are considered.

The Spectrum Analyzer settings can be directly found in the measurement diagrams.

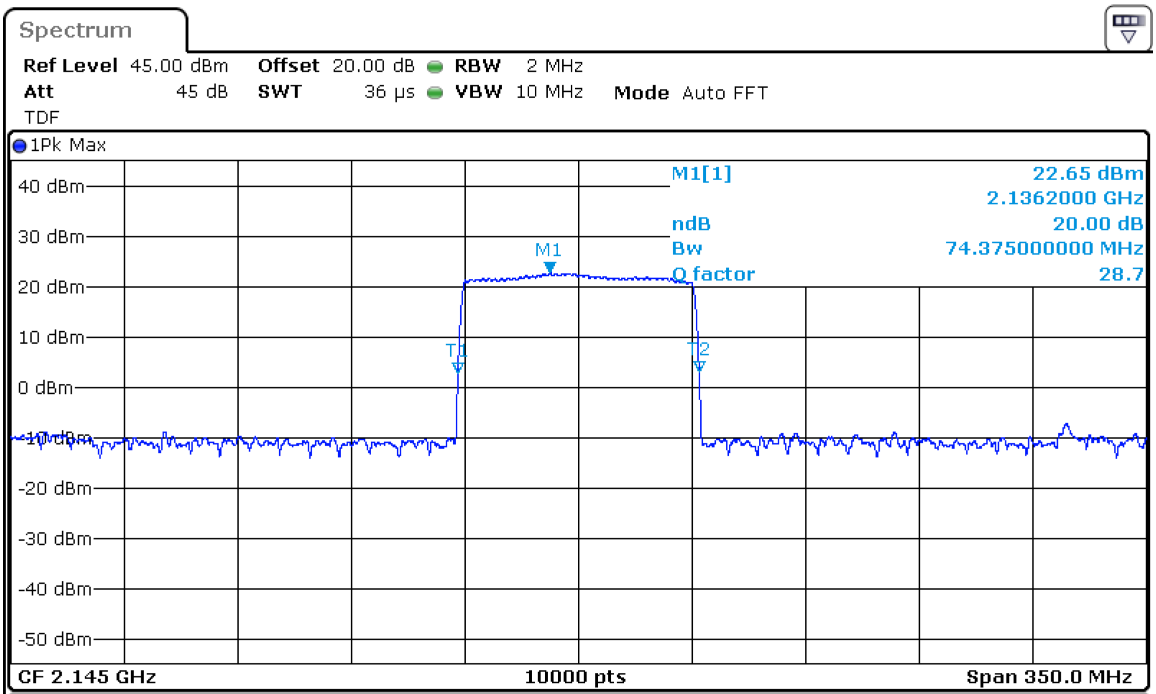
4.6.2 TEST PROTOCOL

Band 66 AWS 1700, downlink				
Highest Power Frequency [MHz]	**Output Power [dBm]**	**Lower Highest Power -20 dB Frequency [MHz]**	**Upper Highest Power -20 dB Frequency [MHz]**	**20 dB Bandwidth [MHz]**
2136.20	22.65	2107.778	2182.153	74.375

Remark: Please see next sub-clause for the measurement plot.

4.6.3 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

Frequency Band = AWS 1700, Direction = RF downlink



Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.1362 GHz	22.65 dBm	ndB down	74.375 MHz
T1		1	2.107778 GHz	2.82 dBm	ndB	20.00 dB
T2		1	2.182153 GHz	2.93 dBm	Q factor	28.7

3.3 Out of band rejection AWS1700L 2.14500G
_20dB

4.6.4 TEST EQUIPMENT USED

- Conducted

4.7 FREQUENCY STABILITY

The frequency stability test case was not carried out, as any frequency errors are eliminated by the given system architecture. This is achieved by generating the LOs in the head-end station and the LOs in the remote unit with a common reference clock. This reference clock is transmitted from the head-end station to the remote unit and regenerated there. This means that the same reference frequency is used for all signal conversions (up- and down-conversion as well as analog-to-digital and digital-to-analog conversion) and any frequency error in the reference clock is compensated therefore. This is already clear from the measurement markings for the occupied bandwidth (26 dB bandwidth). It can be seen that the DUT has no influence on the frequency (comparison between input and output signal). In addition, it is operationally necessary for the frequency deviation to be significantly smaller than the spectral distance between the transmission bandwidth edge and the channel bandwidth edge in order to meet the signal quality requirement (signal purity) and such ensure that the fundamental emissions remain within the authorized bands of operation.

4.8 FIELD STRENGTH OF SPURIOUS RADIATION

Standard FCC Part § 2.1053, § 27.53

The test was performed according to:
ANSI C63.26

Test date: 2023-11-13

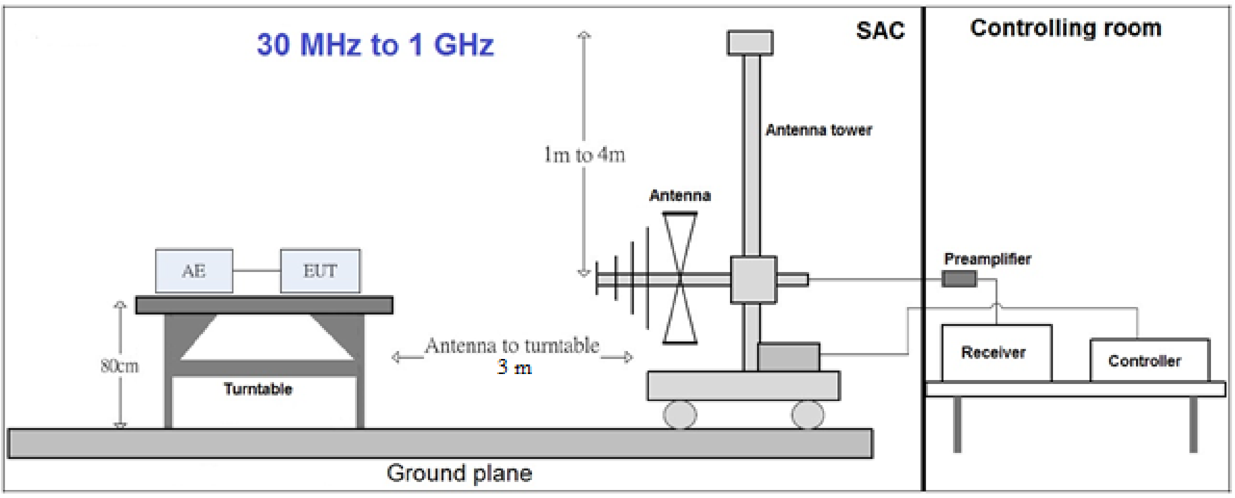
Environmental conditions: 23 °C ± 5 K; 40 % r. F. ± 20 % r. F.

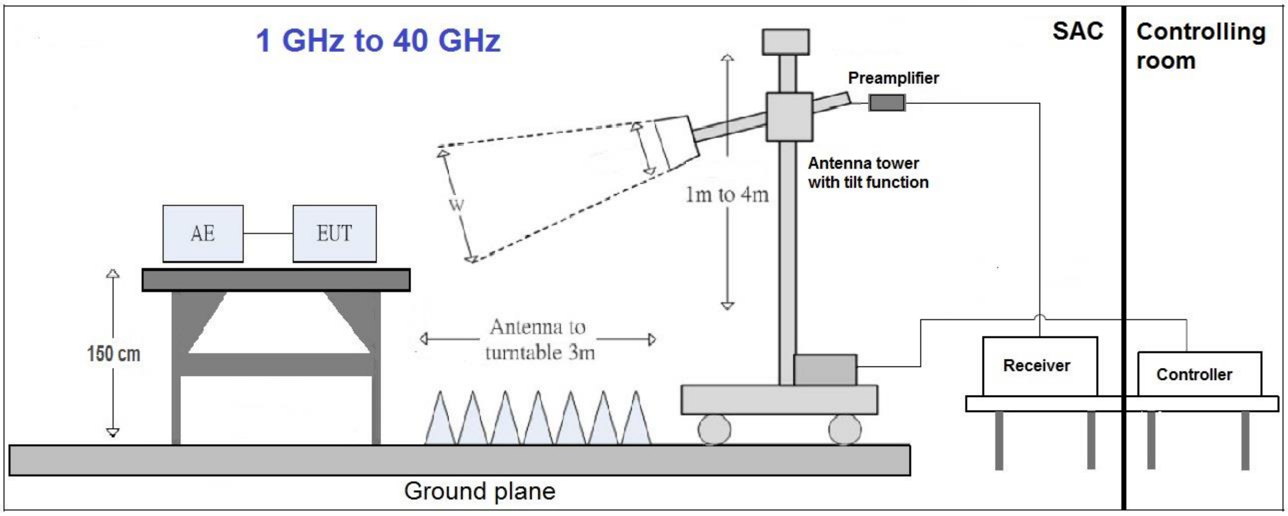
Test engineer: Thomas Hufnagel

4.8.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the applicable radiated spurious emission measurements.

The EUT was connected to the test setup according to the following diagram:





The test set-up was made in accordance to the general provisions of ANSI C63.4 in a typical installation configuration. The Equipment Under Test (EUT) was set up on a non-conductive table 1.5 x 1.5 m² in the semi-anechoic chamber, 0.8 meter above the ground or floor-standing arrangement shall be placed on the horizontal ground reference plane.. The influence of the EUT support table that is used between 30–1000 MHz was evaluated. For the initial measurements, the receiving antenna is varied from 1-4 meter height and is changed in the vertical plane from vertical to horizontal polarization at each frequency. The highest emissions between 30 MHz to 1000 MHz were analyzed in details by operating the spectrum analyzer and/or EMI receiver in quasi-peak mode to determine the precise amplitude of the emissions.

The measurement procedure is implemented into the EMI test software BAT EMC from NEXIO. Exploratory tests are performed at 3 orthogonal axes to determine the worst-case orientation of a body-worn or handheld EUT. The final test on all kind of EUTs is also performed at 3 axes. A pre-check is performed while the EUT is powered by a DC power source. ?

1. Measurement above 30 MHz and up to 1 GHz

Step 1: Preliminary scan
This is a preliminary test to identify the highest amplitudes relative to the limit.
Settings for step 1:
- Antenna distance: 10 m
- Detector: Peak-Maxhold/RMS (FFT-based)
- Frequency range: 30 – 1000 MHz
- Frequency steps: 30 kHz
- IF–Bandwidth: 120 kHz
- Measuring time/Frequency step: 5 ms
- Turntable angle range: –180° to 180°
- Turntable step size: 30°
- Height variation range: 1 – 4 m
- Height variation step size: 1 m
- Polarisation: Horizontal + Vertical

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

Step 2: Adjustment measurement
In this step the accuracy of the turntable azimuth and antenna height will be improved. This is necessary to find out the maximum value of every frequency.
For each frequency, which was determined the turntable azimuth and antenna height will be adjusted. The turntable azimuth will slowly vary by ± 45° around this value. During this action, the value of emission is continuously measured. The turntable azimuth at the highest emission will be recorded and adjusted. In this position, the antenna height will also slowly vary by ± 100 cm around the antenna height determined. During this action, the value of emission is also continuously measured. The antenna height of the highest emission will also be recorded and adjusted.
- Detector: Peak – Maxhold; RMS
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: ± 30 ° around the determined value
- Antenna Polarisation: max. value determined in step 1

Step 3: Final measurement with QP detector
With the settings determined in step 3, the final measurement will be performed:
EMI receiver settings for step 4:
- Detector: Quasi-Peak (< 1 GHz); RMS; Peak
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 1 s

After the measurement a plot will be generated which contains a diagram with the results of the preliminary scan and a chart with the frequencies and values of the results of the final measurement.

3. Measurement above 1 GHz
The following modifications apply to the measurement procedure for the frequency range above 1 GHz:
Step 1:
The Equipment Under Test (EUT) was set up on a non-conductive support at 1.5 m height in the semi-anechoic chamber. Absorbers are placed around and between the turn table and the antenna tower.
All steps were performed with one height (1.5 m) of the receiving antenna only.
The EUT is turned during the preliminary measurement across the elevation axis, with a step size of 30 °.
The turn table step size (azimuth angle) for the preliminary measurement is 15 °.
Step 2:
The maximum RFI field strength was determined during the measurement by rotating the turntable (±180 degrees) and varying the height of the receive antenna (h = 1 ... 4 m) with a additional tilt function of the antenna.The turn table azimuth will slowly vary by ± 15°.
EMI receiver settings (for all steps):
- Detector: Peak, Average
- IF Bandwidth = 1 MHz

Step 3:
Spectrum analyser settings for step 3:
- Detector: Peak/Average
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 1 MHz
- Measuring time: 1 s

Remarks to the measuremtent in the frequency range between 1 GHz and 18 GHz:

In this range for noise reduction it was necessary to bring the antenna into a distance of 1 m to the test table with the DUT.
This also means that the height scan in this range is between 1.33 m for the lowest position and 2.33 m in the highest positions: This equates to the same scan range of the DUT as in 3 m antenna distance to the DUT and a height variation between 1 m and 4 m.

4.8.2 TEST REQUIREMENTS/LIMITS

Abstract from FCC Part § 2.1053:

FCC Part 2.1053; Measurement required: Field strength of spurious radiation:

Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of § 2.1049, as appropriate.

Part 27; Miscellaneous Wireless Communication Services

Subpart C – Technical standards

§27.53 – Emission limits

Abstract § 27.53 FCC:

(h) AWS emission limits—(1) General protection levels. Except as otherwise specified below, for operations in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz, and 2180-2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least 43 + 10 log10 (P) dB.

4.8.3 TEST PROTOCOL

General considerations concerning the limits:

The measuring bandwidth of 1 MHz was chosen according the test requirements exept at the bands from 30 MHz to 1 GHz: At these bands reducing of measurement bandwidth was done.
Also outside the downlink frequency band at lower frequencies the measurement bandwidths were reduced to have the possibility to record the spurious emissions at these lower frequencies.

At frequencies were measuring bandwidths were reduced also the limit lines were reduced acoording the given formula:

$$p\ RBWreduced\ [dBm] = 10 * \log\left(RBWreduced\ [kHz] — 1000\ kHz\right) + pRBW\ 1000\ kHz[dBm]$$

Hereby “p” are the limit lines’ values.

Considerations to MIMO operation:

At this test the two output ports ANT 1 and ANT 2 are together in function according KDB 935210 D02 v04r02 chapter II (o) (2).

Measurement tables (showing the highest value. "worst case") with one antenna

At this tables the highest peak value of spurious radiation per frequency test band is shown.

Band 66 AWS 1700, downlink;						
Spurious Freq. [MHz]	**Spurious Level [dBm]**	**Pin [dBm]**	**Detector**	**RBW [kHz]**	**Limit [dBm]**	**Margin to Limit [dB]**
47.8/hor..	-44.9	-4.8	RMS	100	-23.0	21.9
58.5/vert.	-42.0	-4.8	RMS	100	-23.0	19.0
17142.6/hor.	-22.5	-4.8	RMS	1000	-13.0	9.5
17535.9/ver.	-24.4	-4.8	RMS	1000	-13.0	11.4
26661.0/hor.	-65.6	-4.8	RMS	1000	-13.0	52.6
26668.5/vert.	-65.4	-4.8	RMS	1000	-13.0	52.4

Measurement tables (showing the highest value. "worst case") with two antennas (MIMO)

At this tables the highest peak value of spurious radiation per frequency test band is shown.

Band 66 AWS 1700, downlink;						
Spurious Freq. [MHz]	**Spurious Level [dBm]**	**Pin [dBm]**	**Detector**	**RBW [kHz]**	**Limit [dBm]**	**Margin to Limit [dB]**
47.9/hor..	-45.2	-4.8	RMS	100	-23.0	22.2
48.0/vert.	-41.4	-4.8	RMS	100	-23.0	18.4
17738.2/hor.	-24.0	-4.8	RMS	1000	-13.0	11.0
17742.1/ver.	-23.5	-4.8	RMS	1000	-13.0	10.5
26647.2/hor.	-66.0	-4.8	RMS	1000	-13.0	53.0
26653.5/vert.	-65.7	-4.8	RMS	1000	-13.0	52.7

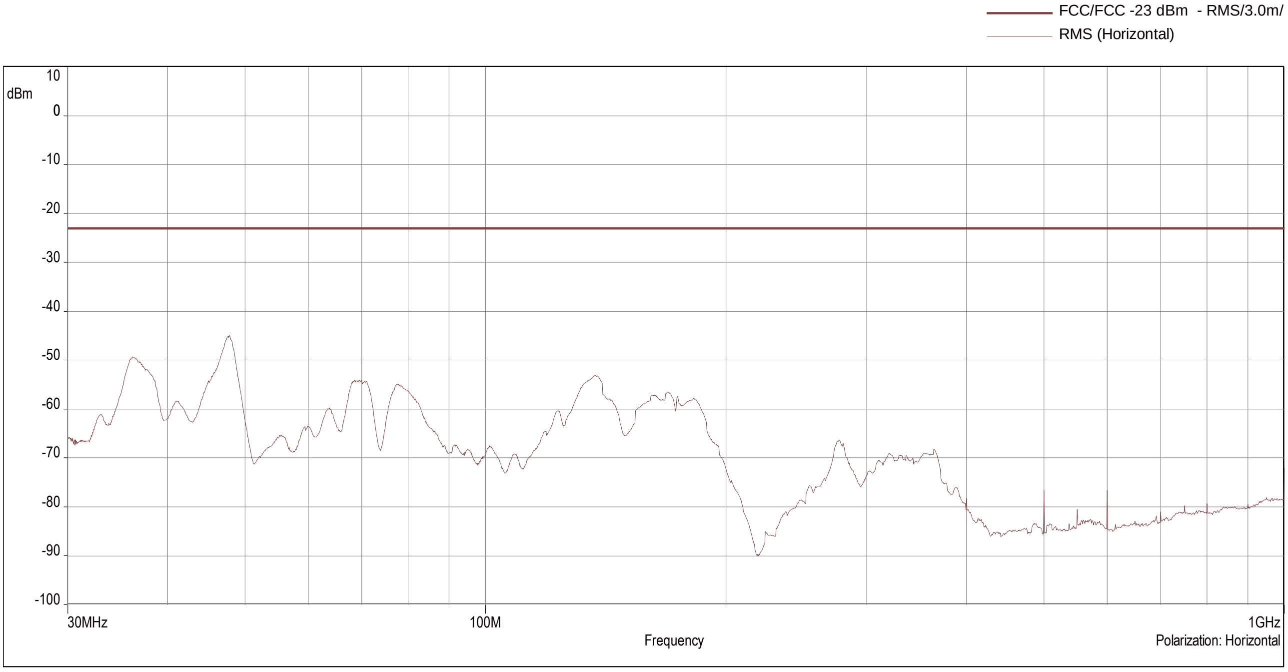
Abbreviations:
Hor.: horizontal position
Vert.: vertical position

Remark: Please see next sub-clause for the measurement plot.

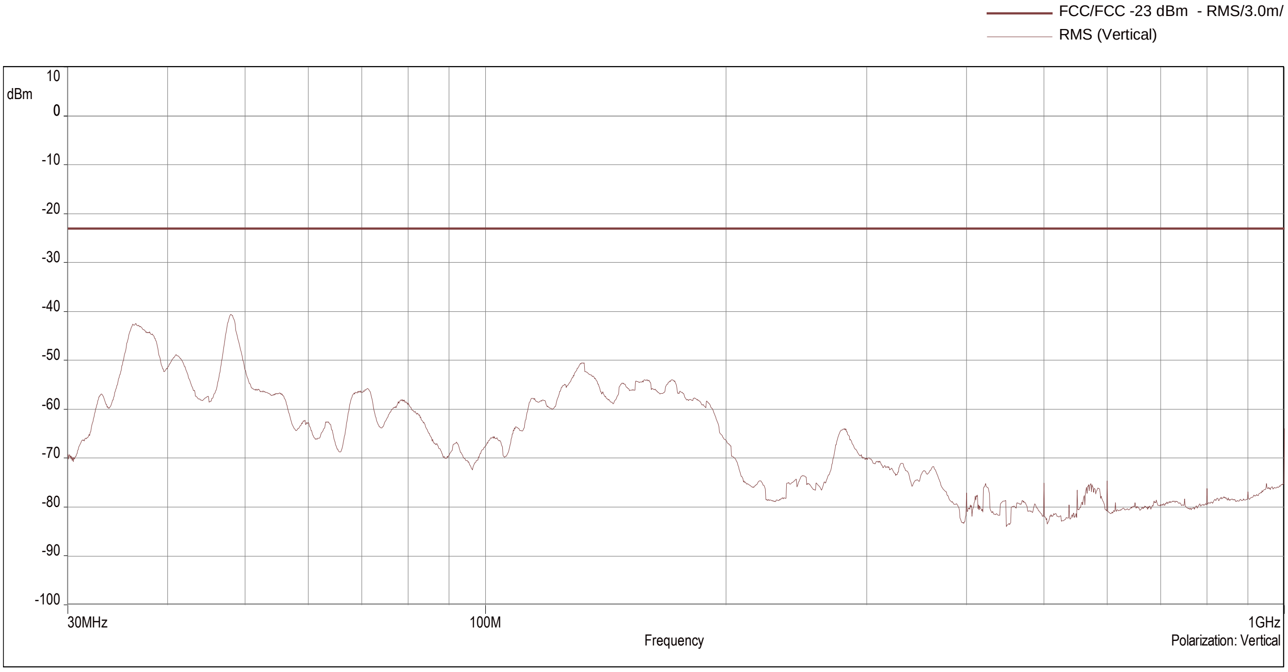
4.8.4 MEASUREMENT PLOTS (SHOWING THE HIGHEST VALUE. "WORST CASE") WITH ONE ANTENNA

4.8.4.1 Frequency Band = Band AWS 1700, ANT 1. Direction = RF Downlink

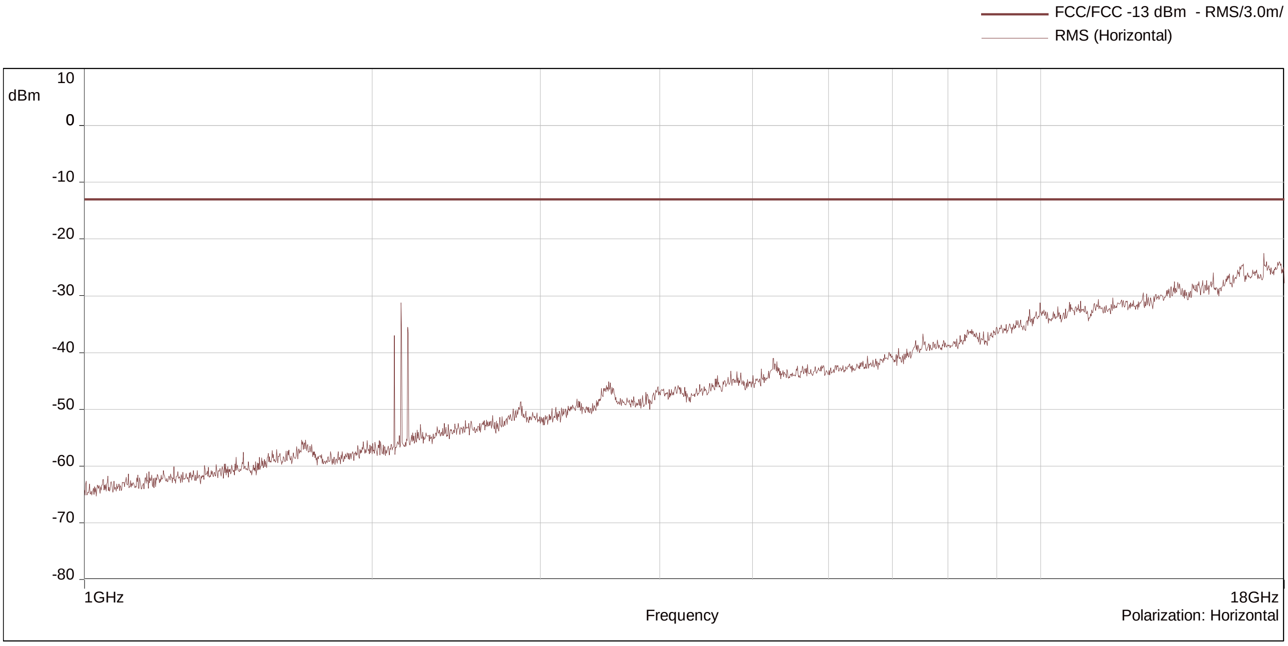
30 MHz - 1 GHz, horizontal



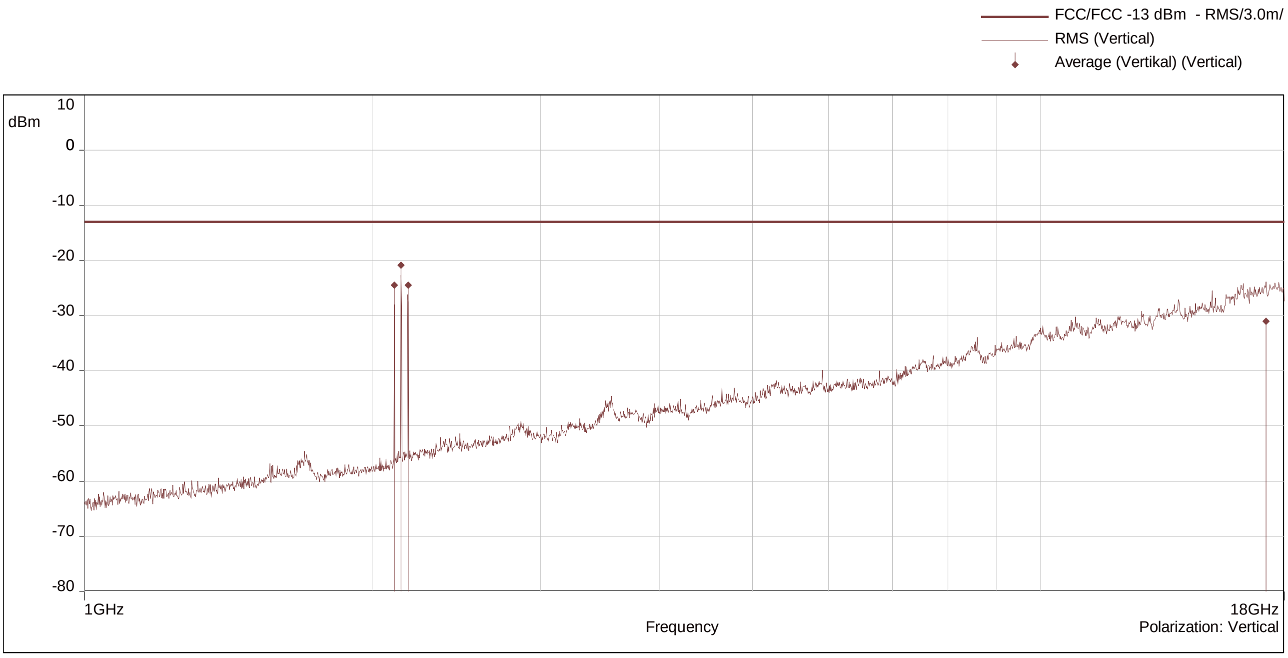
30 MHz - 1 GHz, vertical



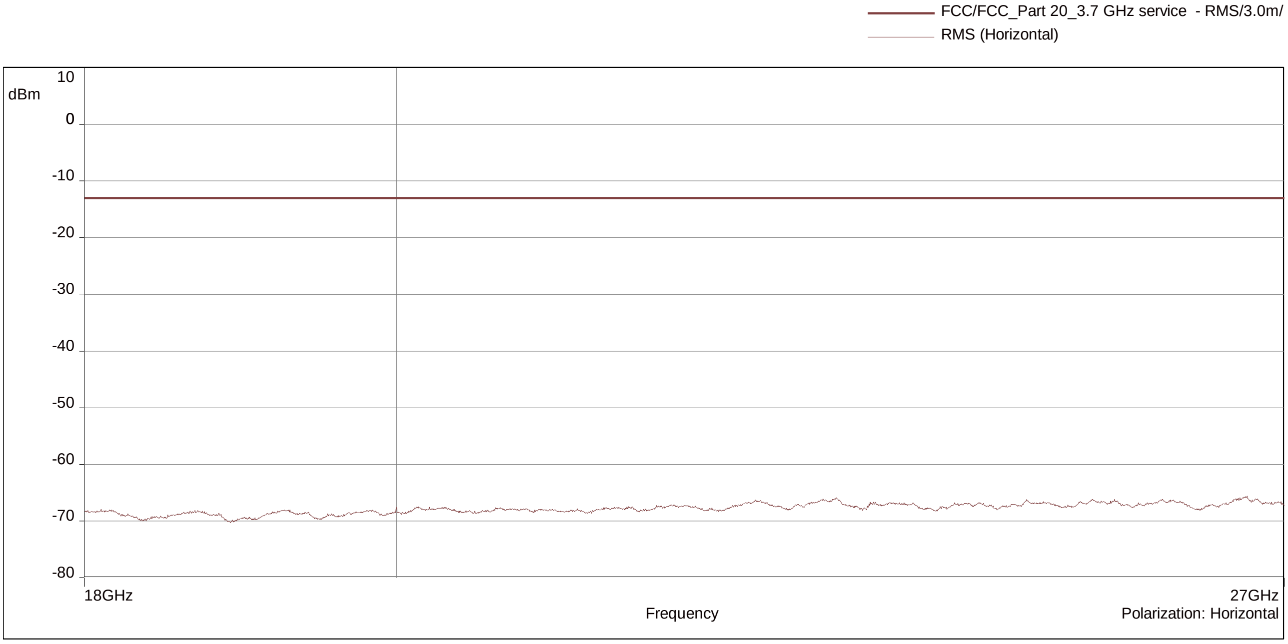
1 GHz - 18 GHz, horizontal



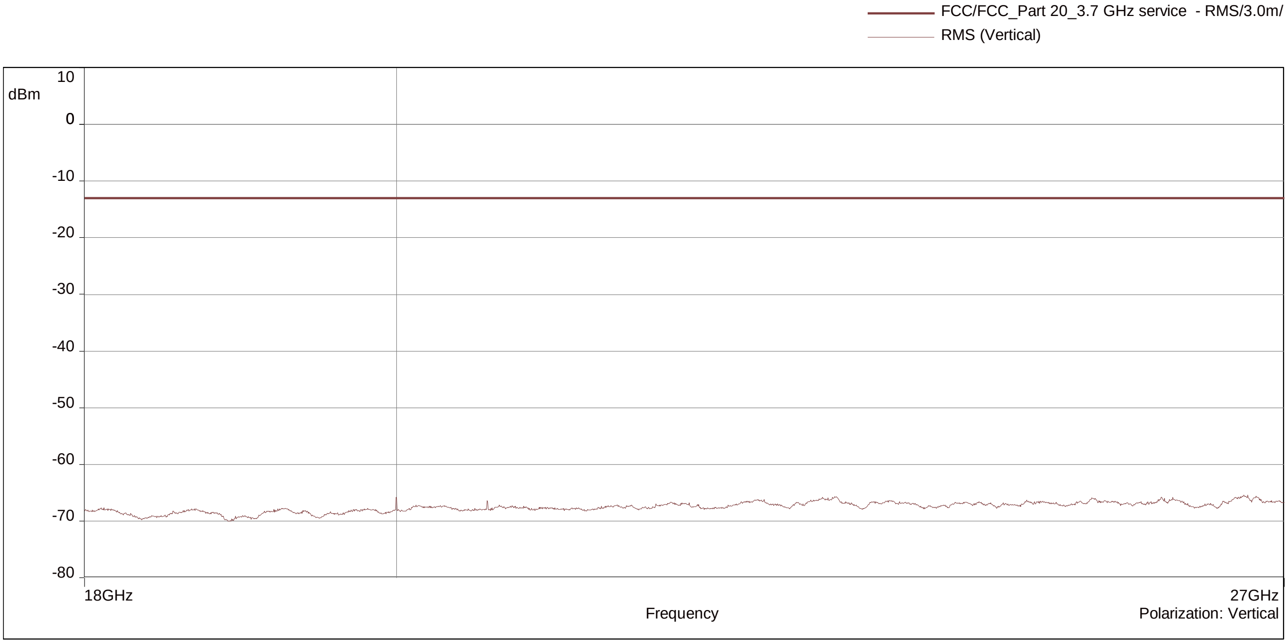
1 GHz - 18 GHz, vertical



18 GHz - 27 GHz, horizontal

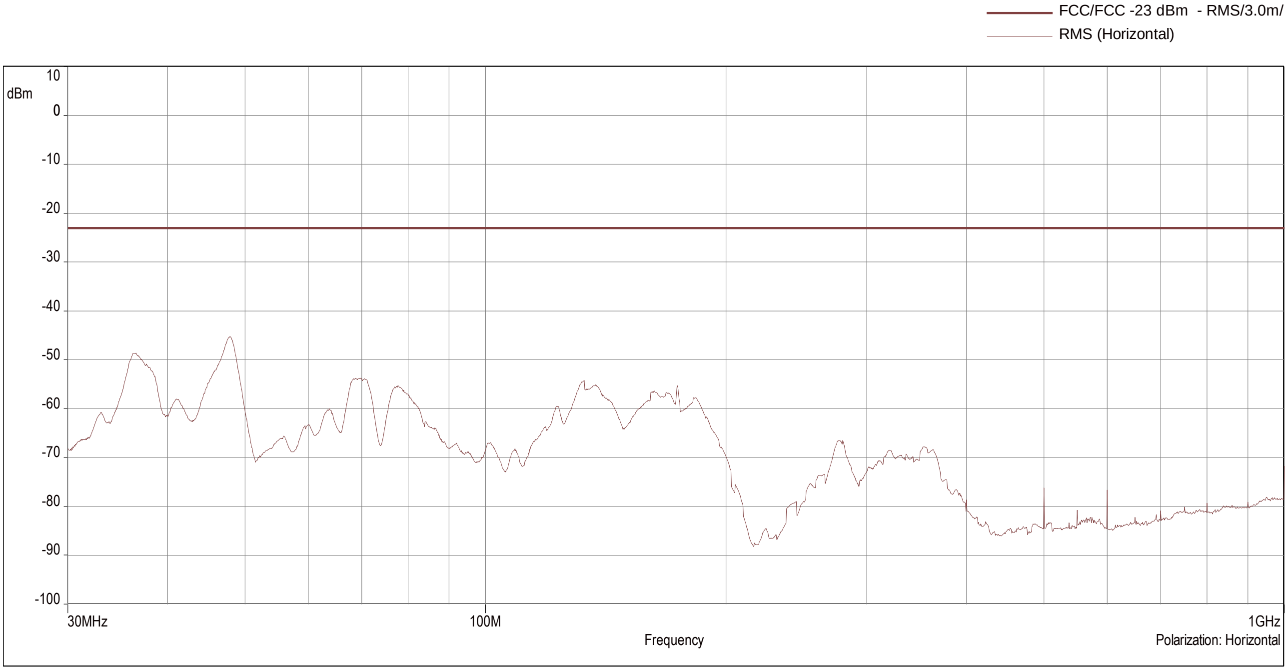


18 GHz - 27 GHz, vertical

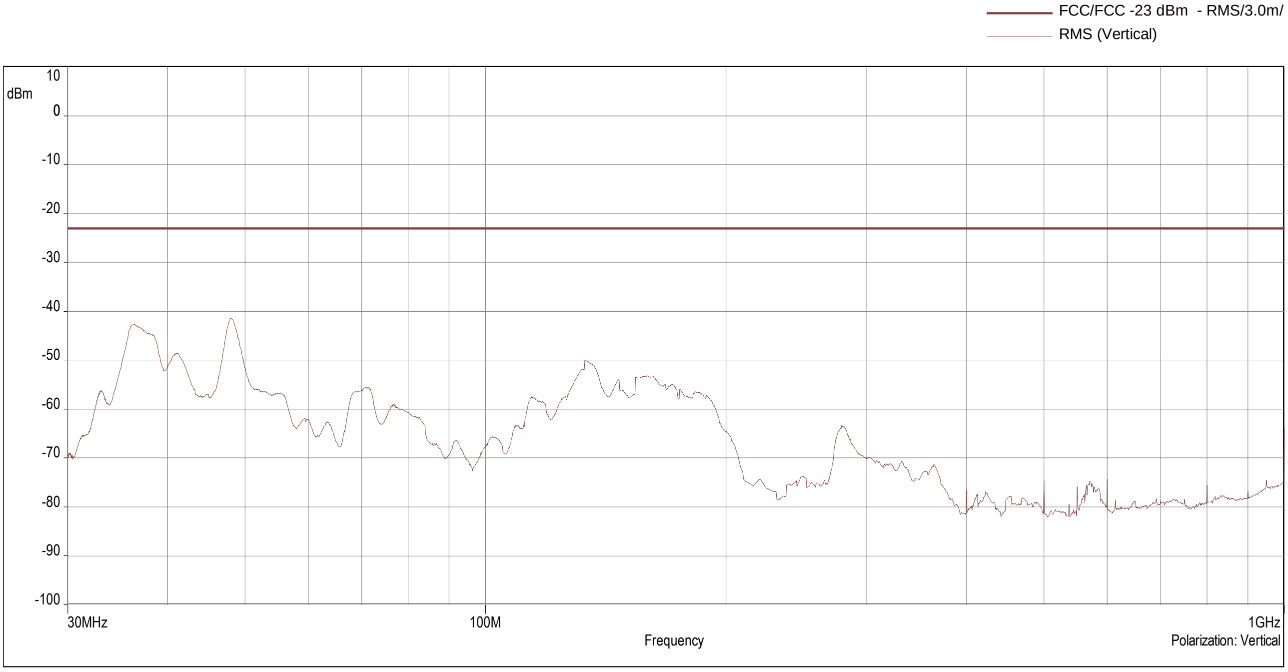


4.8.4.2 Frequency Band = Band AWS 1700, ANT 1and 2 (MIMO). Direction = RF Downlink

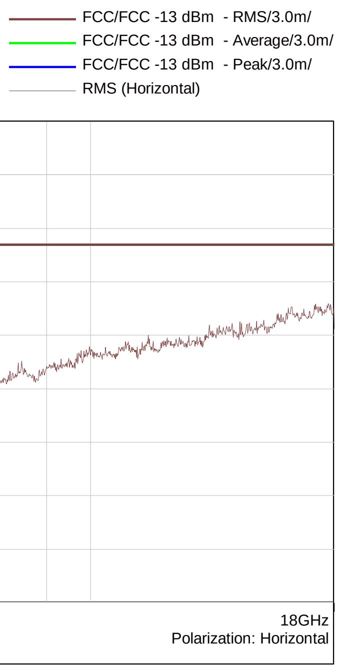
30 MHz - 1 GHz, horizontal



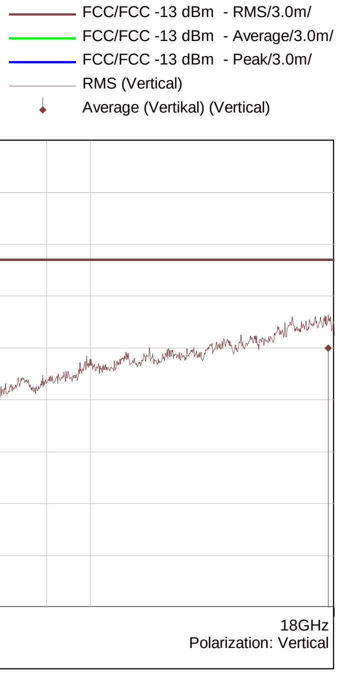
30 MHz - 1 GHz, vertical



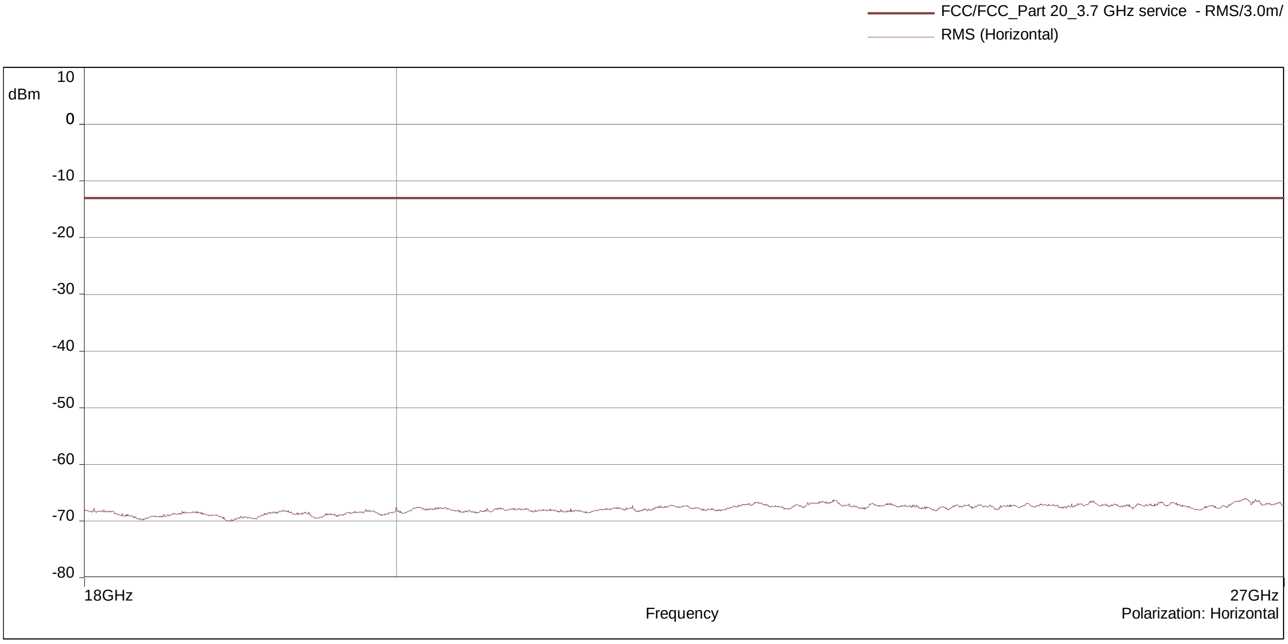
1 GHz - 18 GHz, horizontal



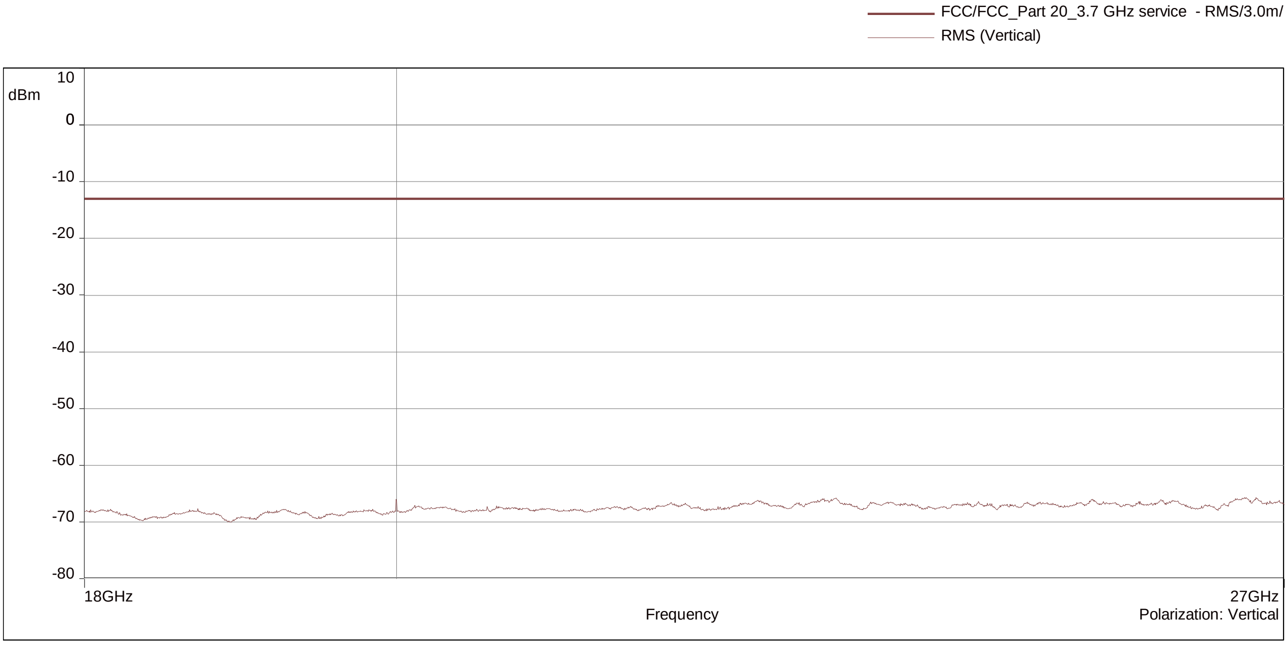
1 GHz - 18 GHz, vertical



18 GHz - 27 GHz, horizontal



18 GHz - 27 GHz, vertical



4.8.5 FIELD STRENGTH CALCULATIONS

FS = SA + AF + CL + PA

Where as:

FS = Field strength
SA = EMC test receiver reading
AF = Antenna factor
CL = Cable loss
PA = Preamplifier

4.8.6 TEST EQUIPMENT USED

- Radiated Emissions

5 TEST EQUIPMENT

5.1 CONDUCTED EMISSIONS

Ref.No.	Type	Description	Manufacturer	Inventory no.	Last Calibration	Calibration Due
1.1	FSV40 *	Signal Analyzer 10 Hz - 40 GHz	Rohde & Schwarz	E-003139	2023-10	2024-10
1.2	SMBV100A	Vector Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	E-003206	2023-01	2025-01
1.3	n. a.	Switchbox for Wireless	Bureau Veritas	E-003951	2023-10	2024-10
1.4	LabView	Software	NI	Auto Messung 1 Channel V8	---	---

5.2 RADIATED EMISSIONS

Ref.No.	Type	Description	Manufacturer	Inventory no.	Last Calibration	Calibration Due
1.5	ESU40 *	EMI test receiver 10 Hz - 40 GHz	Rohde & Schwarz	E-003138	2023-10	2024-10
1.6	CBL 6111C	Antenna 30 MHz – 1 GHz	Chase	E-003226	2021-10	2024-10
1.7	HL 025	Antenna 1 GHz - 18 GHz	Rohde & Schwarz	E-003259	2022-10	2024-10
1.8	MWH-1826/B	Antenna 18 GHz – 26.5 GHz	ARA Inc.	E-003233	2022-11	2024-11
1.9	AM1431 *	Pre amplifier 10 kHz – 1 GHz	Miteq	E-003365	2023-10	2024-10
1.10	AFS4-00102000 *	Preamplifier 100 MHz - 20 GHz	Miteq	E-003633	2023-10	2024-10
1.11	AMP-18000-40000-60-18-2.9-F	Preamplifier 18 GHz - 40 GHz	TTE Europe	E-004003	2023-10	2024-10
1.12	CO3000	Controller SAC	Innco systems GmbH	E-003052 with Software 1.02.62	---	---
1.13	BAT-EMC	Software	Nexio	V 2023.0.3.0	---	---

6 ANTENNA FACTORS, CABLE LOSS AND SAMPLE CALCULATIONS

This chapter contains the antenna factors with their corresponding path loss of the used measurement path for all antennas.

6.1 ANTENNA CHASE CBL 6111C (30 MHZ – 1 GHZ)

(d_{Limit} = 3 m)

Frequency	AF	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-20 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
30	18.6	0.6	0.29	0.04	0.23	0.02	0.0	3	3
50	6.0	0.9	0.39	0.09	0.32	0.08	0.0	3	3
100	9.7	1.2	0.56	0.14	0.47	0.08	0.0	3	3
150	7.9	1.6	0.73	0.20	0.59	0.12	0.0	3	3
200	7.6	1.9	0.84	0.21	0.70	0.11	0.0	3	3
250	9.5	2.1	0.98	0.24	0.80	0.13	0.0	3	3
300	11.0	2.3	1.04	0.26	0.89	0.15	0.0	3	3
350	12.4	2.6	1.18	0.31	0.96	0.13	0.0	3	3
400	13.6	2.9	1.28	0.35	1.03	0.19	0.0	3	3
450	14.7	3.1	1.39	0.38	1.11	0.22	0.0	3	3
500	15.6	3.2	1.44	0.39	1.20	0.19	0.0	3	3
550	16.3	3.5	1.55	0.46	1.24	0.23	0.0	3	3
600	17.2	3.5	1.59	0.43	1.29	0.23	0.0	3	3
650	18.1	3.6	1.67	0.34	1.35	0.22	0.0	3	3
700	18.5	3.6	1.67	0.42	1.41	0.15	0.0	3	3
750	19.1	4.1	1.87	0.54	1.46	0.25	0.0	3	3
800	19.6	4.1	1.90	0.46	1.51	0.25	0.0	3	3
850	20.1	4.4	1.99	0.60	1.56	0.27	0.0	3	3
900	20.8	4.7	2.14	0.60	1.63	0.29	0.0	3	3
950	21.1	4.8	2.22	0.60	1.66	0.33	0.0	3	3
1000	21.6	4.9	2.23	0.61	1.71	0.30	0.0	3	3

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
distance correction = -20 * LOG (d_{Limit}/ d_{used})
Linear interpolation will be used for frequencies in between the values in the table.
Tables show an extract of values.

6.2 ANTENNA ROHDE & SCHWARZ HL 025 (1 GHZ – 18 GHZ)

Frequency	AF	Corr.	cable loss 1 (relay + cable inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit. atten-uator & pre-amp)	cable loss 4 (to receiver)		
MHz	dB (1/m)	dB	dB	dB	dB	dB		
1000	24.4	-19.4	0.99	0.31	-21.51	0.79		
2000	28.5	-17.4	1.44	0.44	-20.63	1.38		
3000	31.0	-16.1	1.87	0.53	-19.85	1.33		
4000	33.1	-14.7	2.41	0.67	-19.13	1.31		
5000	34.4	-13.7	2.78	0.86	-18.71	1.40		
6000	34.7	-12.7	2.74	0.90	-17.83	1.47		
7000	35.6	-11.0	2.82	0.86	-16.19	1.46		

Frequency	AF	Corr.	cable loss 1 (relay inside chamber)	cable loss 2 (inside chamber)	cable loss 3 (outside chamber)	cable loss 4 (switch unit. atten-uator & pre-amp)	cable loss 5 (to receiver)	used for FCC 15.247
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	
3000	31.0	-23.4	0.47	1.87	0.53	-27.58	1.33	
4000	33.1	-23.3	0.56	2.41	0.67	-28.23	1.31	
5000	34.4	-21.7	0.61	2.78	0.86	-27.35	1.40	
6000	34.7	-21.2	0.58	2.74	0.90	-26.89	1.47	
7000	35.6	-19.8	0.66	2.82	0.86	-25.58	1.46	

Frequency	AF	Corr.	cable loss 1 (relay inside chamber)	cable loss 2 (High Pass)	cable loss 3 (pre-amp)	cable loss 4 (inside chamber)	cable loss 5 (outside chamber)	cable loss 6 (to receiver)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	dB
7000	35.6	-57.3	0.56	1.28	-62.72	2.66	0.94	1.46
8000	36.3	-56.3	0.69	0.71	-61.49	2.84	1.00	1.53
9000	37.1	-55.3	0.68	0.65	-60.80	3.06	1.09	1.60
10000	37.5	-56.2	0.70	0.54	-61.91	3.28	1.20	1.67
11000	37.5	-55.3	0.80	0.61	-61.40	3.43	1.27	1.70
12000	37.6	-53.7	0.84	0.42	-59.70	3.53	1.26	1.73
13000	38.2	-53.5	0.83	0.44	-59.81	3.75	1.32	1.83
14000	39.9	-56.3	0.91	0.53	-63.03	3.91	1.40	1.77
15000	40.9	-54.1	0.98	0.54	-61.05	4.02	1.44	1.83
16000	41.3	-54.1	1.23	0.49	-61.51	4.17	1.51	1.85
17000	42.8	-54.4	1.36	0.76	-62.36	4.34	1.53	2.00
18000	44.2	-54.7	1.70	0.53	-62.88	4.41	1.55	1.91

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables. switch unit. distance correction. amplifier (if applicable)
Linear interpolation will be used for frequencies in between the values in the table.
Tables show an extract of values.

6.3 ANTENNA ARA INC. MWH-1826-B (18 GHZ – 26.5 GHZ) PARTIALLY IN CONJUNCTION WITH PRE-AMPLIFIER MITEQ JS43-1800-4000: THE USE OF THE PRE-AMPLIFIER IS DEPENDENT FROM THE FIELD STRENGTH

Frequency	AF	Corr.	cable loss 1 (inside chamber)	cable loss 2 (pre-amp)	cable loss 3 (inside chamber)	cable loss 4 (switch unit)	cable loss 5 (to receiver)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB
18000	40.2	-23.5	0.72	-35.85	6.20	2.81	2.65
18500	40.2	-23.2	0.69	-35.71	6.46	2.76	2.59
19000	40.2	-22.0	0.76	-35.44	6.69	3.15	2.79
19500	40.3	-21.3	0.74	-35.07	7.04	3.11	2.91
20000	40.3	-20.3	0.72	-34.49	7.30	3.07	3.05
20500	40.3	-19.9	0.78	-34.46	7.48	3.12	3.15
21000	40.3	-19.1	0.87	-34.07	7.61	3.20	3.33
21500	40.3	-19.1	0.90	-33.96	7.47	3.28	3.19
22000	40.3	-18.7	0.89	-33.57	7.34	3.35	3.28
22500	40.4	-19.0	0.87	-33.66	7.06	3.75	2.94
23000	40.4	-19.5	0.88	-33.75	6.92	3.77	2.70
23500	40.4	-19.3	0.90	-33.35	6.99	3.52	2.66
24000	40.4	-19.8	0.88	-33.99	6.88	3.88	2.58
24500	40.4	-19.5	0.91	-33.89	7.01	3.93	2.51
25000	40.4	-19.3	0.88	-33.00	6.72	3.96	2.14
25500	40.5	-20.4	0.89	-34.07	6.90	3.66	2.22
26000	40.5	-21.3	0.86	-35.11	7.02	3.69	2.28
26500	40.5	-21.1	0.90	-35.20	7.15	3.91	2.36

Sample calculation

E (dB μV/m) = U (dB μV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables. switch unit. distance correction. amplifier (if applicable)
Linear interpolation will be used for frequencies in between the values in the table.
Table shows an extract of values.

7 MEASUREMENT UNCERTAINTIES

KDB 935210 D05	**ECL**
Power measurement	0,68 dB
Measuring AGC threshold level	0,90 dB
Out of band rejection	0,90 dB
Input-versus-output signal comparison	0,91 dB
Mean power output	0,90 dB
Measuring out-of-band/out-of-block (including intermodulation) emissions and spurious emissions	0,90 dB
Out-of-band/out-of-block emissions conducted measurements	0,90 dB
Spurious emissions conducted	2,18 dB
Spurious emissions radiated mesurements	5,38 dB
Total frequency uncertainty	2×10^{-7}

Reference : ECL-MU5.4.6.3-EMC-14-001-V03.00 MU Wireless.xlsx

8 PHOTO REPORT

Please see separate photo report.

ANNEX A: ACCREDITATION CERTIFICATE (FOR INFORMATION)

The accreditation relates to competences stated on the accreditation certificate. The current certificate is available on the homepage of the DAkkS and can be downloaded under accredited bodies with the processing number:

https://www.dakks.de/en

ANNEX B: ADDITIONAL INFORMATION PROVIDED BY CLIENT

None.

****** End of test report *****